The Effect of Point Velocity Probe Size on Groundwater Velocity Estimation in Noncohesive Sediments

by

Natalie Lynn Burris

Submitted to the Department of Geology
and the Faculty of the Graduate School of the University of Kansas
Master of Science
2014

____
Dr. J.F. Devlin, Chair

____
Dr. George Tsoflias, Committee Member

____
Dr. Stephen Hasiotis, Committee Member

Date Defended: December 15, 2014

The Thesis Committee for Natalie Lynn Burris certifies that this is the approved version of the following thesis:

The Effect of Point Velocity Probe Size on Groundwater Velocity Estimation in Noncohesive Sediments

Committee:

____
Dr. J.F. Devlin, Chair

____
Dr. George Tsoflias, Committee Member

____
Dr. Stephen Hasiotis, Committee Member

Date Approved: December 15, 2014

Abstract

The point velocity probe (PVP) was developed to make *in situ* measurements of groundwater velocity in unconsolidated sediments and has been tested both in the laboratory and in the field. The purpose of this study was to evaluate the PVP under controlled laboratory conditions to determine if varying the PVP diameter size and the relative sediment size -fine-grained sand, medium-grained sand and gravel- affected the accuracy of the measurements of direction and magnitude. Four PVP sizes (11-cm, 6-cm, 4-cm, and 2-cm) were designed with the same relative angles between the injection port and detector sets (45° and 75°). Results for tests in medium-grained and fine-grained sands demonstrate that PVP diameter size was found to affect both the measurements for velocity and direction. As the diameter of the PVP was decreased, the accuracy of groundwater direction (α) decreased and as the diameter of the PVP decreased, the accuracy of the velocity measurement increased slightly. In gravel, reasonable estimates of groundwater velocity were obtained, but flow direction (α) was more problematic and could not be reliably determined with accuracies < 50° of the expected value. Measurements made with the smallest PVP were inferior to those obtained with a larger probe. The problem with measurements made with the PVP in gravel is likely due to the relative size of the probe injection ports and the tracer path to the detectors where pore size affect the measurement and the tracer does not behave in the expected manner as it does in sand. It is concluded that PVPs can be useful in measuring groundwater velocity in gravel, if appropriately large probe sizes are employed.

Acknowledgements

There are so many people to thank and acknowledge, but first, I thank my family and friends. I appreciate your support. They were always there and saw the daily challenges I experienced through the years as a nontraditional graduate student. Without support from home, this would be impossible.

I want to acknowledge my advisor, Dr. J.F. "Rick" Devlin for his patience and guidance. I have known Rick for over ten years and he positively influenced my education and understanding of science. I greatly respect him and thank him for his mentorship. Never a day that he did not give his best effort to me.

I also want to thank my fellow graduate students. My peers have been crucial in helping me with the daily challenges of being a graduate student, especially with the everyday teaching, laboratory work, and course work. Many thanks to Kevin Walter, Brian Gibson, Dennis Eck, Ian Bowen, Peter Schillig, Rubina Fidous, Angela Eichler, and Jim Lyons.

I would also like to thank the faculty in the Department of Geology for support and their ability to be flexible for me, especially since I am not a traditional graduate student. I thank my graduate committee for their time and input on my research project.

And finally, I acknowledge everyone that contributed financial support required for coursework and research. I want to thank the Geology Department Scholarship Endowment and the Kansas Department of Health and Environment – Bureau of Environmental Remediation for their financial support for tuition.

Table of Contents

Figures

Tables

Appendices

1.0 Introduction

1.1 Groundwater velocity and Darcy's Law

Groundwater velocity is an important parameter to measure for the purposes of evaluating contaminant fate and transport, designing remediation systems and managing water resources. It is required to estimate contaminant transport rates, arrival times at receptors, residence times in reactive media, and remediation timeframes (Devlin *et al*., 2012). Groundwater velocity has traditionally been determined by installing groundwater wells or piezometers, measuring groundwater head to determine total hydraulic gradient, and constructing a flow net and potentiometric surface. Groundwater velocity is typically estimated indirectly using the one-dimensional Darcy's Law equation corrected for porosity:

$$v = \frac{q}{n} = -\frac{K\Delta H}{n\Delta x} \tag{1.1}$$

where *v* is the average linear groundwater velocity, *q* is the specific discharge, *n* is porosity. *K* is hydraulic conductivity, *H* is hydraulic head, and *x* is distance parallel to groundwater flow (Labaky, 2007).

The method for estimation of groundwater velocity with Darcy's law has important limitations. Two sources of uncertainty for the method arise from scale issues and heterogeneity. Determination of groundwater-flow direction and velocity represents a larger-scale characterization of velocity, but does not give detailed information about relatively small-scale features in an heterogeneous environment. If head drops are too low to measure with confidence across a site, or if well spacings are far enough apart that intervening heterogeneities confound the applicability of an average hydraulic gradient, Darcy's Law is of limited use (Labaky, 2007). Moreover, uncertainty in *K* can be quite large over small distances (Sudicky, 1986), or exhibit scale dependency, which can also affect the certainty of the velocity estimate (Schulze-Makuch *et al*., 1999).

1.2 Indirect methods for measuring groundwater velocity

Detailed characterization of the distribution of *K* is necessary to accurately estimate groundwater velocity, assuming the adequacy of Darcy's Law calculations. This can be costly and time consuming to obtain. Common methods for conducting such a characterization include estimation of *K* from grain size or core analysis, aquifer testing (gives *in situ* estimates of *K* averaged over large areas), or slug testing (gives localized *in situ* estimates of *K)*. The latter two may involve the injection or removal of water and can be problematic where contamination exists. Also, with any of these approaches more than one borehole or well is required to make a single estimate of velocity (Ballard, 1996). Despite these challenges, much effort has been made to improve *K* estimation both in terms of special variability and accuracy. Arguably, these efforts have only marginally reduced uncertainty in calculated velocities (Devlin and McElwee, 2007).

1.3 Direct methods for measuring groundwater velocity

Methods for direct measurement of groundwater velocity are necessary to further advance the field and to adequately characterize sites due to the limitations of indirect estimation of groundwater velocity (Devlin *et al*., 2012). Several methods have been developed to measure groundwater directly in single boreholes. Natural gradient tests have been conducted with such conservative tracers as bromide and such reactive tracers as lithium and molybdate (LeBlanc *et al*., 1991), and on large scales (Mackay *et al*., 1986). Certain compounds found in the environment can be used as tracers including ^{2}H, tritium ^{3}H (Robertson and Cherry, 1989), ^{18}O, ^{14}C and ^{36}Cl (Clark, 1997). Tracers can be injected into the environment to investigate groundwater flow and have included fluorescent dyes (Kasnavia *et al*., 1999; Sudicky and Illman, 2011). Although tracers tests can be helpful in characterization of groundwater velocity, there is some debate as to whether some of the tracers traditionally considered conservative truly give accurate indications of the water-flow rate. For example, anionic tracers can be influenced by anion exclusion and anion adsorption (Korom and Seaman, 2012). Tracer tests also require multiple wells, a means of accurately dealing with the processes of dispersion, diffusion, sorption, and chemical reactions, which can bias velocity estimations if treated incorrectly (Momii *et al*., 1993). These considerations lead to tracer tests that are commonly expensive and time consuming.

To solve the problems associated with tracer tests, in-well techniques for measuring groundwater velocity have been sought. One of the first of these was the borehole dilution method, which involved flushing a tracer from a well and timing the depletion (Drost *et al*., 1968). The borehole dilution technique has been done with chloride tracers (Ogilivi, 1958), radioactive tracers (Halvey, 1967), deionized water (Tsang *et al.*, 1990), and dye (Pitrak *et al*., 2007). Other methods for direct velocity measurements include the use of heat as a tracer, e.g., the thermal perturbation method (Alden and Munster, 1997) and the heat-pulse flowmeter, which tracks a transported heat pulse from a central heater to perimeter heat sensors to estimate groundwater velocity (Kerfoot and Massard, 1985; Melville et al., 1985; Guthrie, 1986). A colloidal borescope device equipped with a set of lenses, a black light and a miniature video camera, tracks naturally occurring particles flowing within a well screen (Kearl, 1997). Other tools include the passive flux meter that simultaneously measures both the magnitude of horizontal groundwater and contaminant flux (Hatfield *et al*., 2004; Annable *et al*., 2005; Klammler *et al*., 2007), the laser Doppler velocimeter that measures the Doppler shift from a laser light scattered by colloidal in particles inside a well borehole (Momii *et al*., 1993), and an automated on-line instrument method that utilizes carbon dioxide gas diffusion tracer through polymetric tubing in a well to track groundwater movement rates (Patterson *et al*., 2010). Although these techniques can be used to measure groundwater velocity, they all require a properly developed well and a correction for the local distortion of ambient flow caused by the well and any surrounding filter pack. Most of these techniques only measure horizontal velocity, which may not be sufficient for characterizing three-dimensional flow systems in many cases (Bowen, 2010).

To deal with the problems created by flow distortions at wells, attempts have been made to measure groundwater velocity *in situ* directly without a well or borehole. The *in situ* permeable flow sensor (ISPFS) known as Vector Technology was developed for in-well use and then adapted for use without a well. The revised method involved installing the heated cylindrical probe into a dedicated borehole and allowing the unconsolidated aquifer materials to collapse around it (Ballard, 1996; Alden and Munster, 1997; Johnson and Simon, 2007). However, Su (Su *et al*., 2006) suggested that velocity data collected with the ISPFS could be incorrect if the aquifer thermal conductivity was not homogeneous. A limitation shared by the ISPSF and all of the methodologies described above is that the estimated velocities are averaged over arbitrary vertical distances such as well screen lengths or probe sizes, or the horizontal distances of the tracer path (Devlin *et al*., 2012).

1.4 PVP Theory

A novel tool, known as the point velocity probe (PVP), has been developed to overcome some of the limitations of the direct-measurement methods for groundwater velocity reviewed above. The PVP works by tracking the movement of a tracer along the outside perimeter of a cylinder to obtain a measurement of groundwater velocity at the centimeter scale. The unit operates without a well and so avoids well-related flow distortion and the need for a calibration step. PVPs are designed to be installed in unconsolidated, noncohesive sediments and have been shown to be effective in well-sorted sand and poorly-sorted glacial outwash deposits (Schillig *et al.,* 2010; Schillig, 2012). The PVP was first developed by J.F. Devlin and first tested in the field by Labaky (2009). A PVP is inexpensive to construct from readily available materials (Devlin *et al.,* 2009) and is capable of measuring flow both horizontally and vertically (Devlin *et al.*, 2011).

The basic theory describing the PVP is outlined in Labaky (2007). PVP construction is described by Devlin *et al.* (2009). The theory underlying PVP usage is based upon ideal flow around a cylindrical surface where the apparent velocity at a particular point on the PVP can be related the average linear velocity (Bird *et al*., 1960). Flow in an idealized two-dimensional system around smooth circular cylindrical surface in the absence of porous media can be described as,

$$|v(\theta)| = 2v_\infty \sin\theta \tag{1.2}$$

where*, v(Θ)* is the water velocity on the cylinder surface as a function of angle to the incident flow direction, θ. v_∞ is the average linear velocity that is not affected by the presence of the cylinder.

To relate *v(q)* and v_∞, equation 1.2 was integrated over the probe surface to yield:

$$v_\infty = v_{app} \times \frac{0.5}{\gamma} \times ln\left[\frac{tan\left(\frac{\alpha+\gamma}{2}\right)}{tan\left(\frac{\alpha}{2}\right)}\right] \tag{1.3}$$

Where v_{app} is the apparent groundwater velocity on the surface of the probe; α and γ are defined as shown in Figure 1.1.

As an alternative to eq 1.2, the average apparent *angular* velocity over α to $\alpha+\gamma$ was similarly determined:

$$\omega_{app} = \frac{\int_\alpha^{\alpha+\gamma} \omega(\theta)d\theta}{\int_\alpha^{\alpha+\gamma} d\theta} \tag{1.4}$$

where ω_{app} is the average apparent angular velocity over the arc section between the injector and the detection and *ω(Θ)* is an apparent angular velocity of a point.

Angular velocity is related to linear velocity by:

$$\omega(\theta) = {}^{v(\theta)}/_{r} \tag{1.5}$$

where *v(Θ)* is the linear velocity and *r* is the radius of the arc.

Then*, ω(Θ)* is substituted by *v(Θ)/r* to yield:

$$\omega_{app} = \frac{\int_{\alpha}^{\alpha+\gamma} \frac{v(\theta)}{r} d\theta}{\int_{\alpha}^{\alpha+\gamma} d\theta} \tag{1.6}$$

To simplify the equation, *v(Θ)* is replaced by *2* $v_{\infty \infty}$ *sin Θ*:

$$\omega_{app} = \frac{2v_\infty}{r\gamma} \int_{\alpha}^{\alpha+\gamma} sin\theta \; d\theta \tag{1.7}$$

$$\omega_{app} = \frac{2v_\infty}{r\gamma} (\cos\alpha - \cos(\alpha+\gamma)) \tag{1.8}$$

Solving for v_∞ yields:

$$v_\infty = \frac{\omega_{app} \times r \times \gamma}{2(\cos\alpha - \cos(\alpha+\gamma))} \tag{1.9}$$

Next, the angular velocity is converted to a linear velocity (to be used with the linear optimizer):

$$v_\infty = \frac{v_{app} \times \gamma}{2(\cos\alpha - \cos(\alpha+\gamma))} \tag{1.10}$$

Equation 1.10 is equivalent to equation 1.3 over most of the 0 to 180° interval, but equation 1.10 allows the determination of flow direction from a single equation for α. To solve for two detection ports along the surface of the probe, the average linear groundwater velocity is:

$$\frac{v_{app1} \times \gamma}{(\cos\alpha - \cos(\alpha+\gamma))} = \frac{v_{app2} \times \gamma_2}{(cos\alpha - \cos(\alpha - \gamma_2))} \tag{1.11}$$

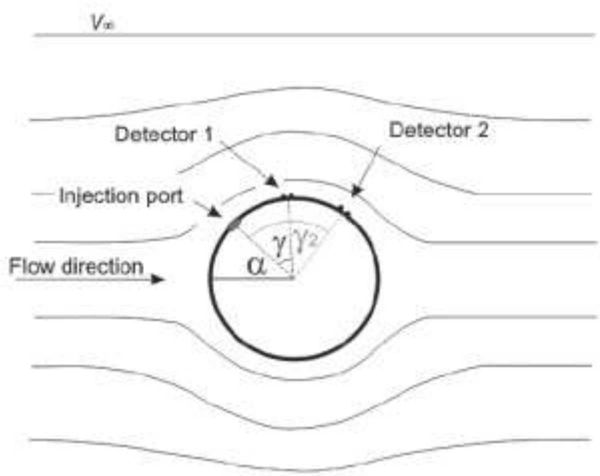


Figure 1.1: Schematic plan view of a PVP in a flow system, showing the α, γ_1 and γ_2 angles. V_{app1} and v_{app2} are measured at detector 1 and detector 2, respectively. Diagram from Devlin 2009.

At each point along the edge of the cylinder will yield a differing apparent velocity, so a PVP with two detectors at two different locations will yield two different apparent velocities (Figure 1.1). In addition, the apparent velocity is a function of the angle α.

Equation 1.11 can be rearranged to find α:

$$\alpha = tan^{-1}\left[\frac{v_{app1}\,\gamma\,(cos\,\gamma_2 - 1) + v_{app2}\,\gamma_2\,(1 - cos\,\gamma)}{v_{app1}\,\gamma\,sin\,\gamma_2 - v_{app2}\,\gamma_2\,sin\,\gamma}\right] \tag{1.12}$$

Equation 1.12 yields the same estimates of α as equation 1.13:

$$v_{app1} ln \left| \frac{tan\left(\frac{\alpha+\gamma}{2}\right)}{tan\left(\frac{\alpha}{2}\right)} \right| = v_{app2} ln \left| \frac{tan\left(\frac{\alpha \pm \Delta\alpha + \gamma}{2}\right)}{tan\left(\frac{\alpha \pm \Delta\alpha}{2}\right)} \right| \tag{1.13}$$

however, solving equation 1.12 gives the α angle directly, whereas equation 1.13 requires a linear optimizer to solve for α.

1.5 PVP Applications

Labaky *et al*. (2007) tested the PVP in a laboratory tank to evaluate the accuracy of the new instrument and conducted modeling to verify that the theory would apply to porous media scenarios. In fact, the applicability of the theory was confirmed by the modeling. In the laboratory, The PVP was able to measure the simulated-groundwater velocity vector to within ±9% magnitude and within ±8° of direction.

PVPs have also been used to measure groundwater velocity above the water table. Berg and Gillham (2010) conducted PVP experiments in a laboratory cell in which the water table could be lowered below or raised above the PVP detectors. The results of the experiments demonstrated that PVPs can measure groundwater velocity in the capillary fringe (Berg and Gillham, 2010).

Further PVP development was undertaken by Bowen (2010) who designed a mini-PVP capable of measuring both vertical and horizontal velocities for deployment around a dipole well. The mini-units were laboratory tested in NeST aquifer simulators (Bowen, 2010; Bowen *et al*., 2012). The Bowen PVP was constructed from a cylindrical gas diffusion stone that was sealed with epoxy resin to limit the passage of saline tracer through the stone only through a small hole in the seal, the injection port. The probe was outfitted with six sets of detectors to measure horizontal and vertical tracer displacement. Laboratory testing of mini-PVPs indicated that the measurements of velocity magnitude were generally within 25% of other velocity estimate methods for the tank. However, the mini-PVP velocity estimates were consistently lower than those measured by larger diameter PVPs. While these findings may have resulted from biases introduced by the probe design, the possible biases were within range of uncertainty produced by porosity estimation and porosity/hydraulic conductivity between tank experiments.

The PVP design was first field tested in a comparison with other methods of direct groundwater velocity measurement by Labaky *et al*. (2009). That work was conducted at the well-studied Canadian Forces Base (CFB) in Borden Ontario, Canada. The PVP unit was constructed of a stainless steel cylinder with an outside diameter of 3 cm. Experiments were conducted within a sheet-pile structure where groundwater flow was controlled. The PVP was tested alongside a Geoflow heat pulse velocimeter, a borehole dilution device, colloidal borescope, and a forced gradient tracer test. Results of the testing indicated that the PVP was capable of measuring groundwater velocity with an accuracy equal to or exceeding that of the other measurement methods, though some bias was noted relative to a Darcy's Law velocity estimation, which may have been caused by aquifer disturbance during installation, or uncertainty in the Darcy parameters and porosity (Labaky *et al*., 2009).

Multilevel PVP experiments were subsequently conducted with PVPs at the CFB field site inside a 7 m wide sheet pile alleyway. The PVPs used for these experiments were constructed of inexpensive plastic pipe and wires. Five boreholes were outfitted with four PVPs each within the alleyway and were monitored on a semi-annual basis for 1.5 years. A hydrocarbon plume was previously created in the alley way as part of a separate experiment. In this experiment, oxygen release compound (ORC) was administered to the plume, under ambient flow conditions, to stimulate aerobic biodegradation of the hydrocarbons. The PVPs were deployed to determine whether or not the biostimulation efforts caused flow variations related to stimulated biological activity. PVPs detected velocity differences in the shallower and deeper zones and found that the velocities were, on average, in agreement with previous characterizations of the site. Both temporal and spatial changes in velocity were observed and partially attributed to the localized influence of bioremediation (Devlin *et al*., 2009).

Finally, at an agricultural site near Woodstock, Ontario, Canada, PVPs were deployed in unconsolidated nitrate-contaminated, glacial sediments. Multilevel PVPs were installed within a denitrification treatment area and were instrumental in identifying and characterizing a zone in which groundwater was moving at more than 20 m/day (Devlin *et al*., 2012).

1.6 Outline of Study and Purpose

PVPs have been constructed of readily available and inexpensive materials with the objective of making them easily available to practitioners. The construction of the units is, however, time consuming and this factor has limited their application at of commercial sites. To help overcome this problem, and increase the potential for implementing new PVP designs, recent work has focused on constructing PVPs with three-dimensional (3D) prototype printers (Walter, *in preparation*). Assembly is greatly simplified with printed PVPs, and the possibility now exists to adapt PVP designs to particular geologic settings. The purpose of this study is to determine the practical limits of PVP diameter in various geological media. For example, large PVP diameters may be useful in highly conductive, coarse-grained aquifers, and small-diameter units may be best suited for direct push applications in silts and sands, because they would cause less aquifer displacement during installation. This work examines PVP performance in media packed NeST aquifer stimulators. The media included medium-grained, fine-grained and gravel to define the probe performance parameters, including precision and accuracy as a function of probe diameter.

1.7 References

Alden, A. S. and C. L. Munster. 1997. Field Test of the *In Situ* Permeable Ground Water Flow Sensor. *Ground Water Monitoring & Remediation* 17 no. 4: 81-88.

Annable, M. D., Hatfield, K., Cho, J., Klammler, H., Parker, B.L., Cherry, J.A., and P.S.C. Rao. 2005. Field-Scale Evaluation of the Passive Flux Meter for Simultaneous Measurement of Groundwater and Contaminant Fluxes. *Environmental Science & Technology* 39 no. 18: 7194-7201.

Ballard, S. 1996. The In Situ Permeable Flow Sensor: A Ground-Water Flow Velocity Meter. *Ground Water* 34 no. 2: 231-240.

Berg, S. J. and R. W. Gillham. 2010. Studies of water velocity in the capillary fringe: the point velocity probe. *Ground Water* 48, no. 1: 59-67.

Bird, W.E., Stewart, R.B., and E.N. Lightfoot. 1960. *Transport Phenomena*; John Wiley & Sons: New York, 123-140.

Bowen, I.R. 2010. Characterization of Dipole Flow System Using Point Velocity Probes. M.S. Thesis, University of Kansas, Department of Geology.

Bowen, I. R., Devlin, J.F., and P.C. Schillig. 2012. Design and Testing of a Convenient Benchtop Sandbox for Controlled Flow Experiments. *Ground Water Monitoring & Remediation* 32, no. 4: 87-91.

Clark, I. D. and P. Fritz. 1997. *Environmental Isotopes in Hydrogeology*. Boca Raton, CRC Press/Lewis Publishers.

Devlin, J.F. and C.D. McElwee. 2007. Effects of Measurement Error on Horizontal Hydraulic Gradient Estimates. *Ground Water* 45 no. 1:62-73.

Devlin, J.F., Tsoflias, G., McGlashan, M., and P. Schillig. 2009. An Inexpensive Multilevel Array of Sensors for Direct Ground Water Velocity Measurement. *Ground Water Monitoring & Remediation* 29, no. 2: 73-77.

Devlin, J.F., Schillig, P.C., Bowen, I., Critchley, C.E., Rudolph, D.L., Thomson, N.R., Tsoflias, G.P., and J.A. Roberts. 2012. Applications and implications of direct groundwater velocity measurement at the centimetre scale. *Journal of Contaminant Hydrology* 127, no. 1-4: 3-14.

Drost, W., Klotz, D., Koch, A., Moser, H., Neumaier, F., and W. Rauert. 1968. Point dilution methods of investigating ground water flow by means of radioisotopes. *Water Resources Research* 4 no. 1: 125-146.

Guthrie, M. 1986. Use of a Geo Flowmeter for the Determination of Ground Water Flow Direction. *Ground Water Monitoring & Remediation* 6 no. 2: 81-86.

Halvey, E., Moser, H., Zellhoffer, O., and A. Zuber. 1967. Borehole Dilution Techniques: A Critical Review. Proceedings of the symposium on Isotopes in Hydrology. Vienna, Austria, I.A.E.A: 531-564.

Hatfield, K., Annable, M., Cho, J., Rao, P.S.C., and H. Klammler. 2004. A direct passive method for measuring water and contaminant fluxes in porous media. *Journal of Contaminant Hydrology* 75 nos. 3–4: 155-181.

Johnson, R. L. and M. A. Simon. 2007. Evaluation of groundwater flow patterns around a dual-screened groundwater circulation well. *Journal of Contaminant Hydrology* 93 nos. 1–4: 188-202.

Kasnavia, T., Vu. D., and Sabatini, D.A. 1999. Fluorescent Dye and Media Properties Affecting Sorption and Tracer Selection. *Ground Water* 37 no. 3: 376-381.

Kearl, P. M. 1997. Observations of particle movement in a monitoring well using the colloidal borescope. *Journal of Hydrology* 200 nos. 1–4: 323-344.

Kerfoot, W. B. and V. A. Massard. 1985. Monitoring Well Screen Influences on Direct Flowmeter Measurements. *Ground Water Monitoring & Remediation* 5 no. 4: 74-77.

Klammler, H., Hatfield, K., and M.D. Annable. 2007. Concepts for measuring horizontal groundwater flow directions using the passive flux meter. *Advances in Water Resources* 30 no. 4: 984-997.

Korom, S. F. and J. C. Seaman. 2012. When "Conservative" Anionic Tracers Aren't. *Ground Water* 50 no. 6: 820-824.

Labaky, W., Devlin, J.F., and R.W. Gillham. 2007. Probe for Measuring Groundwater Velocity at the Centimeter Scale. *Environmental Science & Technology* 41, no. 24: 8453-8458.

Labaky, W., Devlin, J.F., and R.W. Gillham. 2009. Field comparison of the point velocity probe with other groundwater velocity measurement methods. *Water Resources Research* 45, DOI: 10.1029/2008WR007066.

LeBlanc, D.R., Garabedian, S.P., Hess, K.M., Gelhar, L.W., Quadri, R.D., Stollenwerk, K.G., and W.W. Wood. 1991. Large-scale natural gradient tracer test in sand and gravel, Cape Cod, Massachusetts: 1. Experimental design and observed tracer movement. *Water Resources Research* 27 no. 5: 895-910.

Mackay, D. M., Freyberg, D.L., Roberts, P.V., and J.A. Cherry. 1986. A natural gradient experiment on solute transport in a sand aquifer: 1. Approach and overview of plume movement. *Water Resources Research* 22 no. 13: 2017-2029.

Melville, J. G., Molz, F.J., and O. Güven. 1985. Laboratory Investigation and Analysis of a Ground-Water Flowmeter. *Ground Water* 23 no. 4: 486-495.

Momii, K., Jinno, K., and F. Hirano. 1993. "Laboratory studies on a new laser Doppler Velocimeter System for horizontal groundwater velocity measurements in a borehole. *Water Resources Research* 29 no. 2: 283-291.

Ogilivi, N. A. 1958. Electrolytic method for the determination of the ground water filtration velocity (in Russian). In *Bulletin of Science and Technology News*, No. 4, Moscow, Russia: Gosgeoltehizdat.

Patterson, B. M., Annable, M.D., Bekele, E.B., and A.J. Furness. 2010. On-line groundwater velocity probe: Laboratory testing and field evaluation. *Journal of Contaminant Hydrology* 117 nos. 1–4: 109-118.

Pitrak, M., Mares, S., and M. Korb. 2007. A Simple Borehole Dilution Technique in Measuring Horizontal Ground Water Flow. *Ground Water* 45 no. 1: 89-92.

Robertson, W. D. and J. A. Cherry 1989. Tritium as an indicator of recharge and dispersion in a groundwater system in central Ontario*. Water Resources Research* 25 no. 6: 1097-1109.

Schillig, P. C., Tsoflias, G.P., Roberts, J. A., Patterson, E.M., and J.F. Devlin. 2010. Ground-penetrating radar observations of enhanced biological activity in a sandbox reactor. *Journal of Geophysical Research* 115, G00G10, doi:10.1029/2009JG001151.

Schillig, P.C. 2012. Hydrogeologic Control on Bioactive Zone Development in Biostimulated Aquifers. P.h.D. Thesis. University of Kansas, Department of Geology.

Schulze-Makuch, D., Carlson, D.A., Cherkauer, D.S. and P. Mallik. 1999. Scale Dependency of Hydraulic Conductivity in Heterogeneous Media. *Ground Water* 37 no. 6: 904-919.

Su, G. W., Frefield, B.M., Oldenburg, C.M., Jordan, P.D., and P.F. Daley. 2006. Interpreting Velocities from Heat-Based Flow Sensors by Numerical Simulation. *Ground Water* 44 no. 3: 386-393.

Sudicky, E.A. 1986. A natural gradient experiment on solute transport in a sand aquifer: Spatial variability of hydraulic conductivity and its role in the dispersion process. *Water Resources Research* 22 no. 13: 2069-2082.

Sudicky, E. A. and W. A. Illman. 2011. Lessons Learned from a Suite of CFB Borden Experiments. *Ground Water* 49 no. 5: 630-648.

Tsang, C., Hufschmeid, P., and F.V. Hale. 1990. Determination of fracture inflow parameters with a borehole fluid conductivity logging method. *Water Resources Research* 26 no. 4: 561-578.

Walter, K. (in preparation). Title pending. M.S. Thesis, Department of Geology, University of Kansas, Lawrence, KS.

2.0 PVP Experiments in Sandy Media

2.1 Abstract

A series of experiments was completed in a bench-top NeST (Bowen *et al.*, 2012) aquifer simulator using 11-cm, 6-cm, 4-cm, and 2-cm diameter PVPs. The purpose of this evaluation was to determine if the diameters of PVPs affected the accuracy of groundwater flow direction and magnitude measurements, based on comparisons with velocities estimated from the discharge rates and the known PVP orientation in the NeSTs. Experiments were conducted with an estimated linear velocity of approximately 200 cm/day in the simulator. The medium-grained sand had an average porosity of 37% and was classified as a mixture of medium sand and fine sand based upon grain size analysis. The fine-grained sand had an average porosity of 36% and was classified as a mixture of very fine sand and fine sand based upon grain-size analysis. The data from the 6 cm PVP were consistent and comparable to previously published data sets collected with the same sized PVPs under similar conditions (Labaky *et al*., 2007; Devlin, 2009; Bowen *et al*., 2012). Data collected using the 2-cm and 4-cm diameter probes indicated that velocity magnitudes could be determined with accuracies similar to those from the 6-cm probes, but flow direction estimations appeared to decline in accuracy with decreasing probe diameter. Data for the 11-cm diameter PVP indicated that the large probe size obstructed flow in the NeST aquifer simulator sufficiently to create artificial flow diversions related to the NeST boundaries, particularly in the vertical direction. These kinds of biases may be related to the combined effects of the probe diameter and the close proximity of the NeST walls. Fewer problems are expected in field applications where boundaries are far removed from the PVPs, but further work is required to test this hypothesis.

2.2 Introduction

Groundwater velocity must be known to estimate contaminant transport rates, arrival times at receptors, residence times in reactive media, and remediation timeframes (Devlin *et al*., 2012). Groundwater velocity has traditionally been determined by installing groundwater wells or piezometers, measuring groundwater head to determine gradient, and using the one-dimensional Darcy's Law equation corrected for porosity:

$$v = -\frac{q}{n} = -\frac{K\Delta H}{n\Delta x} \tag{2.1}$$

where *v* is the average linear groundwater velocity, *q* is the specific discharge, *n* is porosity. *K* is hydraulic conductivity, *H* is total hydraulic head, and *x* is the distance parallel to groundwater flow between two head measurements (Fetter, 2001).

This method of estimating groundwater velocity has important limitations. Two sources of uncertainty for the method immediately arise: scale issues and heterogeneity (Labaky, 2007). Investigations that depend on equation 2.1 for groundwater velocity represent larger-scale characterization, and do not give detailed information about relatively small scale features in an heterogeneous environment. In many contaminant investigations, such small scale features can be of importance (e.g., Gierczak *et al*., 2007; Bianci *et al*., 2001).

Several methods have been developed to measure groundwater velocity without reference to Darcy's Law to deal with the uncertainties of scale and heterogeneity, including natural gradient tests with tracers (LeBlanc *et al*., 1991; Mackay *et al*., 1986; Robertson and Cherry, 1989; Clark, 1997; Kasnavia *et al*., 1999; Sudicky and Illman, 2011), borehole dilution techniques (Kerfoot and Massard, 1985; Melville *et al*., 1985; Guthrie, 1986; Ogilivi, 1958; Halvey, 1967; Tsang *et al*., 1990, Pitrak *et al*., 2007), heat tracer methods (Alden and Munster, 1997), the colloidal borescope method (Kearl, 1997), the passive flux meter method (Hatfield *et al*., 2004; Annable *et al*., 2005; Klammler *et al*., 2007), the Laser Doppler Velocimeter (Momii *et al*., 1993), and a method that uses an in-well carbon dioxide gas diffusion through polymetric tubing to quantify flow (Patterson *et al*., 2010). PVPs were developed to compliment many of the aforementioned techniques and to offer an alternative that overcomes some of their limitations.

The details of PVP theory were given by Labaky (2007). Briefly, PVPs operate by performing mini tracer tests along the perimeter of the probes. They require good direct contact between the aquifer sediments and the probe surface, which requires the sediments to be noncohesive. PVPs are capable of measuring horizontal and vertical velocity components at the centimeter scale (Labaky, 2007; Devlin 2009; Devlin *et al*., 2011). PVPs have been tested in the laboratory (Labaky, 2007; Bowen, 2010; Berg and Gilham, 2010) and in the field (Labaky *et al*., 2009; Devlin *et al*., 2009; Devlin *et al*., 2012; Schillig, 2012; Kempf *et al*, 2013). In the laboratory, PVPs are capable of measuring groundwater velocity within ± 9% magnitude and within ±8° of direction (Labaky *et al*., 2007); however, with the exception of the work by Bowen (Devlin *et al*., 2012; Bowen 2010), those tests have been limited to probes of about 6-cm diameters, and no systematic comparison of the effects of PVP size on performance have been undertaken. It is proposed here that the size of a PVP affects the accuracy of the velocity and direction measurements in different types of various media; more specifically, that smaller probes produce less accurate measurements. Differences in grain-size in the range of sand deposits are not expected to affect the accuracy of velocity and direction measurements. The purpose of this research is to test that hypothesis and quantify the nature of any dependency of accuracy on probe size, if it exists.

2.3 Methods

2.3.1 PVP Design

PVPs were designed using Trimble Sketchup 8.0 (www.sketchup.com), which is a free, three-dimensional (3D) graphic design software package. Four PVP designs were developed in Sketchup, including 1.9 cm, 4.16 cm, 6.0 cm and 11.34 cm diameter probes, referred to in the text as 2-cm, 4-cm, 6-cm, and 11-cm PVPs, respectively. The angles between the injection ports and the horizontal detectors (γ angles) were maintained as closely as possible (Figure 2.1A). The first horizontal detector was placed approximately (γ_1 =) 45° from the injection port and the second detector set at approximately (γ_2 =) 75° from the injection port (Figure 2.1B).

A) B)

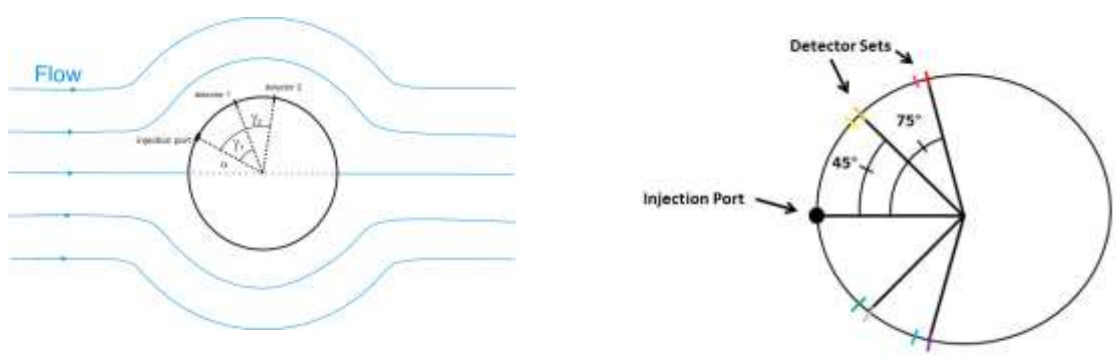


Figure 2.1: (A) Schematic plan view of a PVP in a flow system, showing the α, γ_1 and γ_2 angles. (B) Plan view of PVP and relative angles between the injection port and horizontal wire detector sets.

The timing of the arrival of the saline tracer at a detector depends on the distance between the center of the injection port and the position of the more distal wire in each detector set. The wire pairs making up the detectors were always constructed with the same distances between them, regardless of PVP size. The γ angles varied slightly from one PVP size to another, to accommodate restrictions imposed by the 3D model software (Table 2.1). However, these differences were not expected to be of practical significance in comparisons of the PVPs. Throughout the text, γ angles are referred to as 45° and 75° for simplicity.

Table 2.1: Summary of Actual γ Angles for PVPs

γ Angle for Detector	**6 cm PVP**	**4 cm PVP**	**2 cm PVP**	**11 cm PVP**
45°	47.9°	49.9°	54.0°	46.5°
75°	78.1°	79.5°	84.0°	76.5°

Once the PVP designs were finalized in Sketchup, the Sketchup files (extensions of .skp) were converted to .stl files using the Meshlab freeware utility (http://meshlab.sourceforge.net/). The .stl files were subsequently imported to the 3D printer software Catalyst EX 4.1, which was used to modify, resize, and orient the probes for printing. Renderings of the four Sketchup designs are included in Appendix A.

2.3.2 PVP Printing

PVPs were printed using a Uprint 3D Rapid Prototype Printer located in the soil pedology laboratory of Dr. Daniel Hirmas in Lindley Hall at the University of Kansas. The printing procedure involved two plastics: the model plastic, which was white ABS, and a brown scaffolding plastic that was soluble in a warm base solution (Figure 2.2A). The latter provided structural stability during the printing process and was later removed from the printed model, as describe here. Printing time for a PVP was three to five hours, depending on the number of probes being printed in the same batch.

A) B)

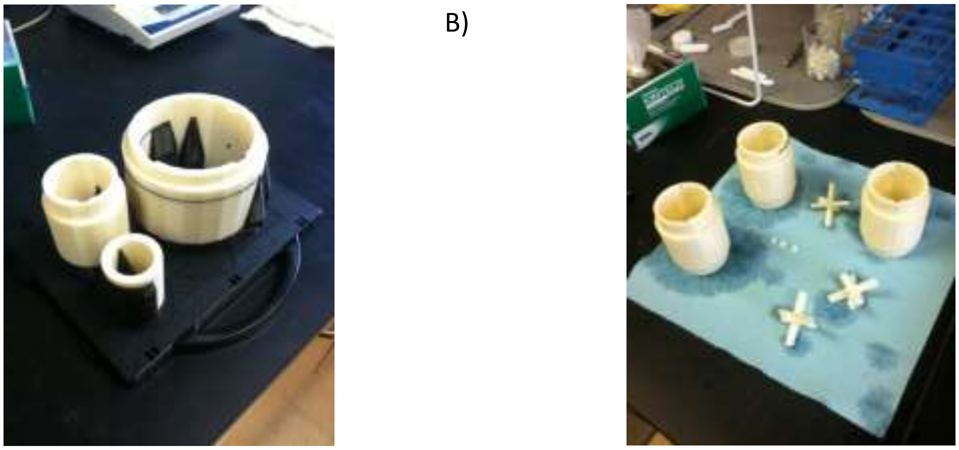


Figure 2.2: (A) Printed PVPs with scaffolding plastic (black) visible. (B) To remove the scaffolding, the models were immersed in a sodium hydroxide bath for several hours.

PVPs were removed from the printer, along with the printing tray, and placed in a heated sodium hydroxide solution to dissolve the scaffolding plastic. Finally, the PVPs were thoroughly rinsed with water and allowed to air dry (Figure 2B).

2.3.3 PVP Assembly

PVPs were assembled by first cutting the appropriate length of Belden® unshielded braided 12 conductor copper wire, 22 gauge (approximately three meters in length for this set of experiments). The outer gray plastic insulation was removed from one end of the wire, exposing about 15 cm of the 12 bundled, color-insulated copper wires. A wire stripping tool was then used to remove approximately 2 cm of colored insulation from each of the 12 wires (Figure 2.3A).

Next, 12 pieces of stainless steel alloy fishing lead (10 lb to 30 lb test lines have been used with success) were cut to a length of approximately 30 cm. The end of a single piece of the stainless steel fishing lead, henceforth referred to as the detector wire, was wrapped to the exposed portion of a single copper wire to make a good physical connection. Inter-looping the wires was found to achieve a strong connection. Once all 12 wires were connected to the copper wires, an iron-nickel based solder was used to secure the physical connection (Figure 2.3B).

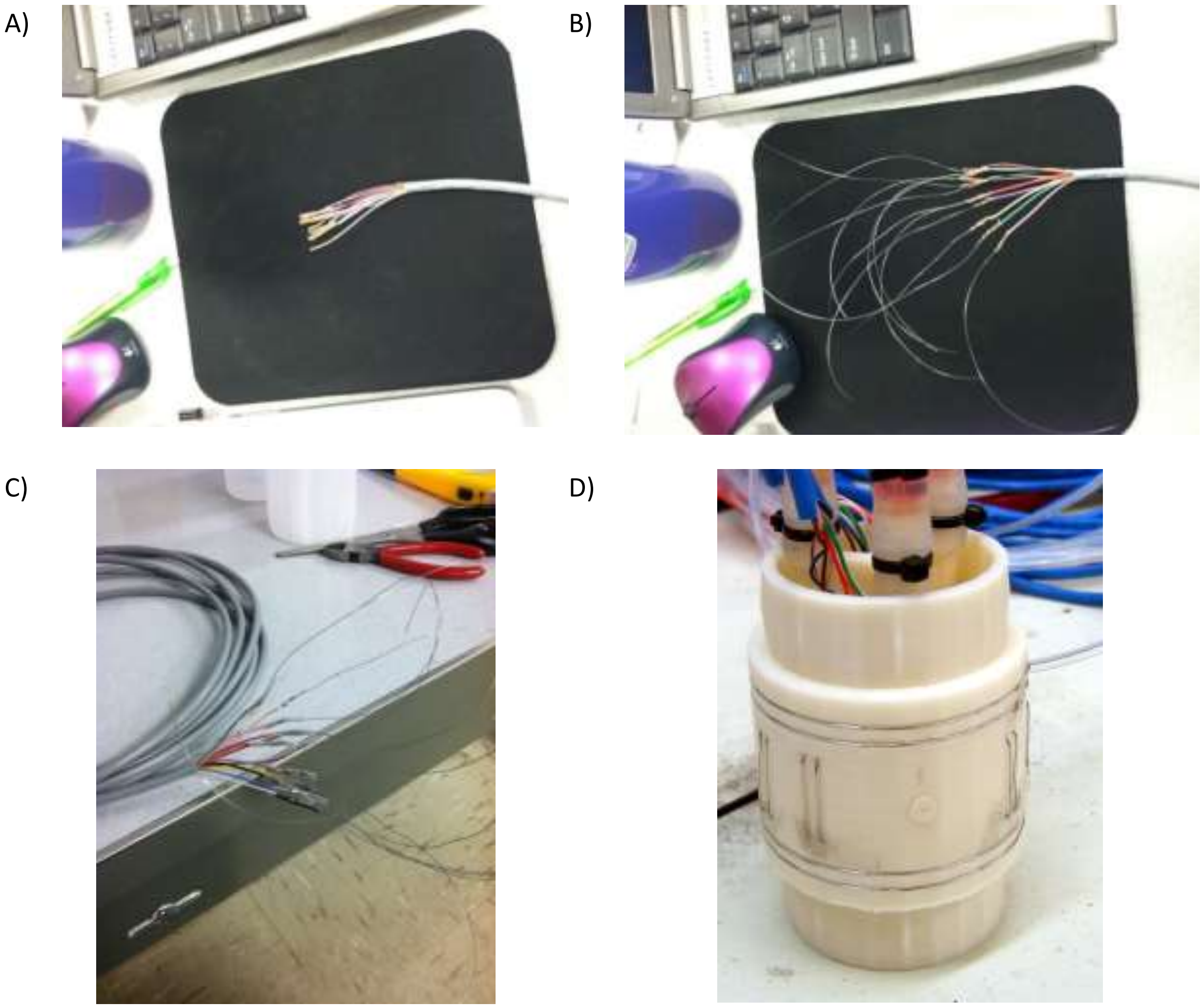


Figure 2.3: (A) Cable preparation for PVP wiring. (B) Stainless steel wire physically appended and soldered to open cable wires. (C) Clean heat shrink applied to each stainless steel and copper wire connection. (D) Fully assembled PVP with wiring, tubing, and injection port screen.

To minimize the chance of short circuiting, and to add strength to the wire connections, twelve lengths of 3 – 5 cms of Pan-Shrink® 1/8” (3.2mm) clear heat shrink ID 0.125”(1.6mm) tubing was placed around each wire connection and heated with a lighter flame to achieve a tight fit.

The stainless steel wires were attached to the PVPs using guide holes printed into the probe bodies. The stainless steel wires were tightened, cut to size, and the ends glued into place with super glue. The wires were placed in a consistent configuration, based upon the insulation color of each wire strand (Figure 2.4), to facilitate connection to the datalogger and minimize the chance of errors during set up.

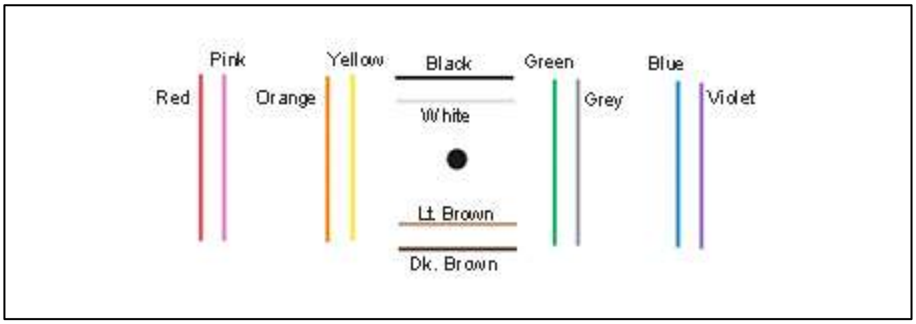


Figure 2.4: Layout of wire color for all PVP designs. Vertical lines represent horizontal flow detector wires, and the horizontal lines depict the vertical detector wires.

Tubing for the injection port (1/16” inner diameter and 1/8” outer diameter flexelene tubing, Eldon James, Corporation brand) was installed by feeding the tube through the open top of the PVP into the injection port hole and securing it in place with super glue. Excess tubing was cut so that the injection tube was flush with the outside of the PVP. A finishing button with a small hole in it was then glued over the terminus of injection port tube to help prevent invasion by sand (Figure 3D).

The tubing support structure was then fed onto the injection tubing and placed on top of the PVP (except for the 2 cm diameter PVP, which was not designed with a tube support structure). Zip ties, stainless steel wiring, and super glue were used to secure the tubing and support structure.

The injection system was constructed using three pieces of 3/16” inner diameter × 1/8” outer diameter clear vinyl tubing and plumbing them onto a 1/8” T-type plastic connector (Thermo Scientific

Nalgene brand). Three plastic clamps were threaded onto the plastic tubing. A 60 mL plastic syringe was connected to one of the tubes with a plastic clamp and 1 mL syringe was connected to the other open tube end with a plastic clamp (Figure 2.5). This system was described in detail by Devlin *et al.* (2012).

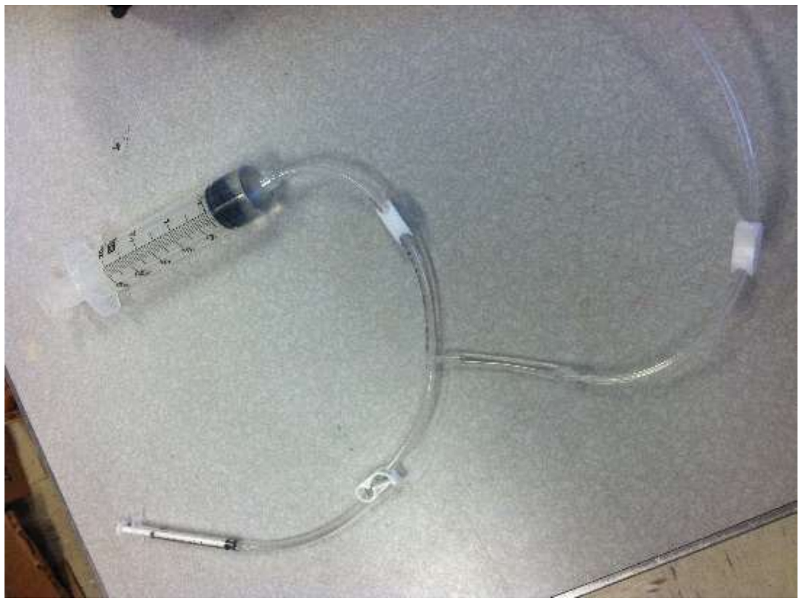


Figure 2.5: Injection system configuration for each PVP.

2.3.4 Tank Construction

A benchtop NeST aquifer simulator was constructed using readily available materials as described by Bowen (2012). The NeST consisted of a three compartment system where open water was stored in an upgradient reservoir that was connected to the sand tank. These two compartments were then contained within a larger effluent tank. The downgradient side of the sand tank was perforated with holes to allow water to flow into the effluent tank. Water was pumped from the effluent tank to the upgradient reservoir with a peristaltic pump, to drive water flow through the porous medium in the sand tank (Figure 2.6).

Figure 2.6: Newly constructed NeST aquifer simulator apparatus.

2.3.5 Experiment Methodology

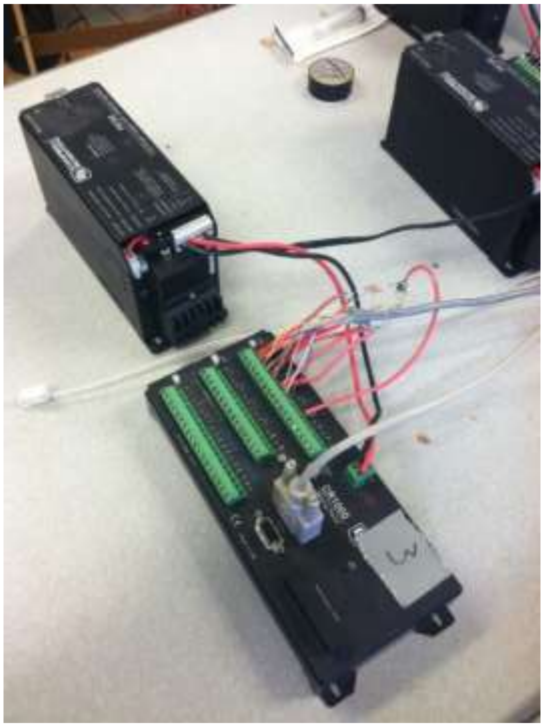
A series of experiments was completed with each of the four PVP sizes. The tests were repeated in medium sand, and fine sand to assess the PVP limitations as a function of grain size. The tank was wet packed before each experiment by adding water to the upgradient reservoir throughout the packing procedure so that the water level in the sand tank was always above the level of the sand or gravel being added. The sand was added to the sand tank in approximately 2 to 3 cm lifts. Once a lift was in place, below the water level, it was sifted by hand to dislodge any trapped air bubbles, merge it with the underlying lifts, and improve the uniformity of the packing generally. For all tests, the PVPs were held in position during packing so that the potential of a zone of disturbed packing developing next to the PVP due to digging, coring or direct push installations (i.e., skin effects, see Labaky *et al*., 2009) could be disregarded. A skin effect is the disturbed material around the PVP surface due to displacement of porous media caused by installation of the PVP.

The PVP injection line was prefilled with tracer solution to avoid introducing air to the saturated porous media once the sand tank was packed and saturated. Finally, the water circulation was begun by activating the peristaltic pump (Figure 2.7).

Figure 2.7: Wet packed sand tank ready for PVP experimentation.

The PVP detectors were wired to a CR-1000 Campbell Scientific data logger as described by Devlin *et al*. (2009) (Figures 2.8A and 2.8B). Each detector was incorporated into a half-bridge circuit that made voltages between the detector wires proportional to the electrical resistance of the solution between the wires.

A)



B)

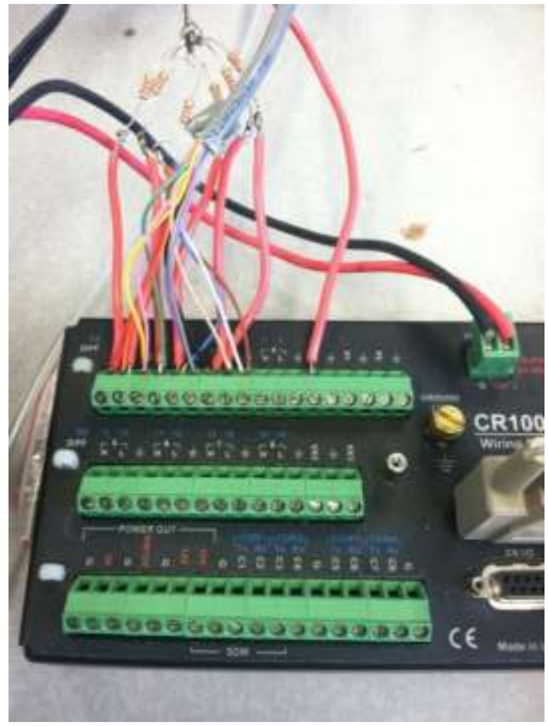


Figure 2.8: Wiring configuration at the datalogger. (A) View with the power supply. (B) View showing resistors that are part of the half bridge circuit.

The datalogger was, in turn, connected to a laptop computer using a commercial cable recommended by Campbell Scientific to convert signals from a 9-pin port to USB port. Campbell Scientific Loggernet 4.2 Software was used to display and record real-time voltage data for each PVP detector. PVP orientations of 15°, 30°, 45° or 75° , relative to the expected flow direction in the sand tank (injector port angle with incident flow vector, assuming flow was directly across the packed tank) were examined in sequential tests by rotating the PVPs to the desired angle prior to each test. Triplicate experiments were conducted for each angle, for each PVP size, and for each media size.

The detector signals were recorded on a millivolt scale ranging from 0 to 1. The measureable range of water electrical resistance was fixed by the selection of 2,200 ohm resistors in the half bridge circuit (Devlin *et al.,* 2009). Once a stable detector baseline was achieved for all half bridges, by circulating water through the porous media for 30 minutes or more, injections of about 0.1 mL, 0.25 mL, 0.5 mL or 1 mL of a sodium chloride tracer solution (0.5g/L or 1 g/L) were made to initiate an experiment. The experiment date, initiation time, PVP size, media size, injection volume, injection tracer concentration, injection speed, α angle, and peristaltic pump speed were documented. Information concerning the variables of each specific experiment is summarized in the table leader for Appendix B. Discharge rate, media pack cross-sectional area for each tank packing event, and media porosity (see section 2.3.8) were also recorded to estimate the expected velocity for each experiment.

2.3.6 Data Processing Methodology

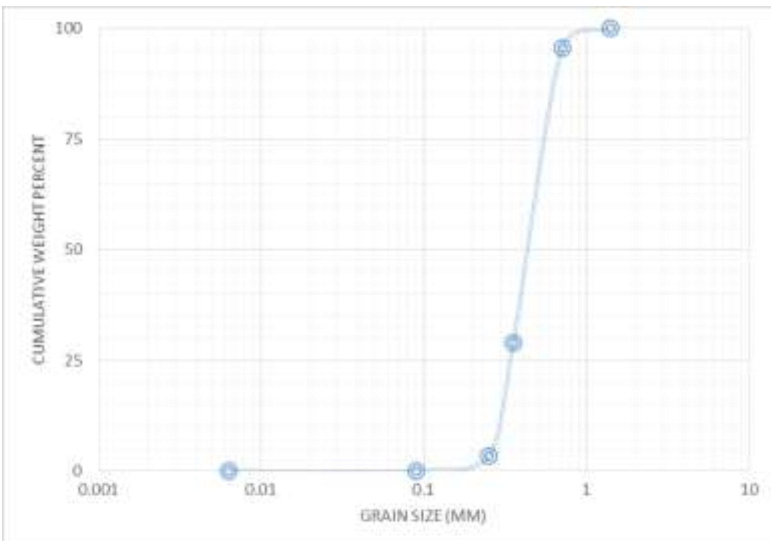
As the saline tracer crosses the wire pair of a detector, the electrical circuit is closed and a signal is generated. The changing signal strength is related to the tracer concentration, so a breakthrough curve is recorded by the datalogger. The data were downloaded from the datalogger to a laptop computer each day, and stored as an ASCII file. The data were then loaded and processed with the VelProbePE (versions 2.2.2. and 3.0) software, as described by Schillig (2012). Curve matching for each breakthrough curve was based on experiment specific data, including the experiment date and start time, distance between the detectors and the injection port, and the PVP diameter. VelProbePE output included calculations for dispersivity, apparent velocity, α, and corrected velocity. All experimental output data were transferred to a Microsoft Access database for data storage and analysis purposes.

2.3.7 Sieve Analysis

Sieve analyses were performed separately for the fine- and medium-grained sands. Thirty grams of oven-dried samples were processed on a sieve-shaking apparatus using 6 sieves with screen openings including: 1.4 mm, 710 µm, 355 µm, 250 µm, 90 µm, and 6.3 µm. The sieves were shaken for two minutes on a mechanical shaker. Particles reaching the bottom pan were considered silt and clay sized particles. Sand was removed from each sieve, and the base pan, and weighed to determine the relative percent of each grain-size range.

Sieve analyses indicated that the medium-grained sand was 66.7% 355 µm and 25.6% 250 µm and was characterized as a mixture of USDA-classified medium-grained sand and fine-grained sand (Figure 2.9A). The fine-grained sand was 61.3% 90 µm and 32.5% 250 µm, corresponding to a USDA classification of 'very fine sand/fine sand' (Figure 2.9B).

A)



B)

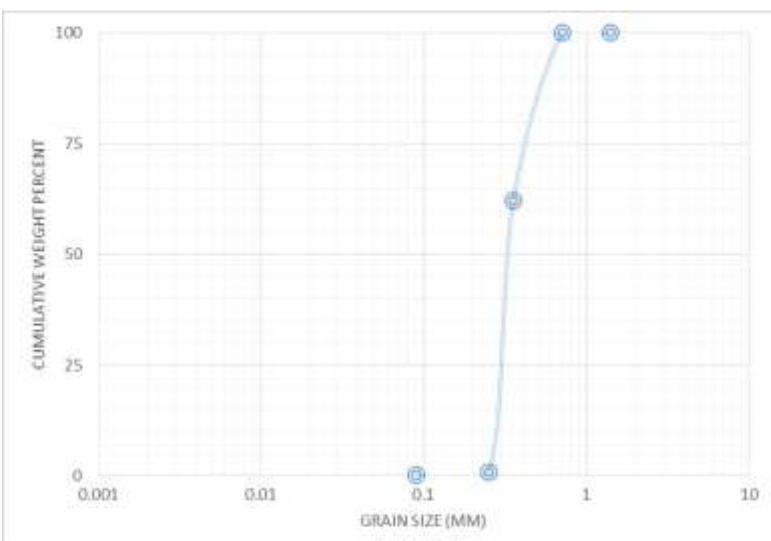


Figure 2.9: (A) Grain size distribution for "medium sand" and (B) grain size distribution for "fine sand". Grain size analysis results were plotted using the HydroSieve v 1.0 program (Devlin, 2014).

2.3.8 Porosity Analysis

A gravimetric analysis was performed in triplicate to determine the relative porosity of the fine-grained and medium-grained sands. Weights for dry beakers, dry beaker with oven-dried sample, and a tap-water saturated beaker sample were recorded. Porosity was calculated using eq 2.2.

$$\phi = \frac{V_V}{V_T} = \frac{Mw}{\rho_w} \times \frac{1}{V_T} = \frac{(wet\ soil\ mass) - (dry\ soil\ mass)}{(density\ of\ water)} \times \frac{1}{V_T} \tag{2.2}$$

Where φ is porosity, V_V is the volume of void space and V_T is the total volume of the bulk material, including the sand and the void space, ρ_w is the density of water (g/cm^3), and M_w is the mass of water (Fetter, 2001).

The porosity analyses indicated that the average porosity for the fine-grained sand was 0.36 and the average porosity of the medium-grained sand was 0.37. The average porosity was used to calculate the expected average discharge-based velocity, v_d, for each PVP experiment, using equation 2.3.

$$v_d = \frac{Q}{\varphi A} \tag{2.3}$$

Where Q is the discharge through the tank, i.e., pumping rate (L^3/T), and A is the saturated cross-sectional area of the tank (L^2).

The agreement between a PVP measurement of velocity, v_{meas}, and v_d depends on the accuracy and of v_d, which in turn depends on the accuracy and precision of the porosity measurements, which were found by as much as ±20% (Bowen 2010). Therefore, disagreements between v_d and PVP measurements of velocity cannot be ascribed entirely to the PVPs.

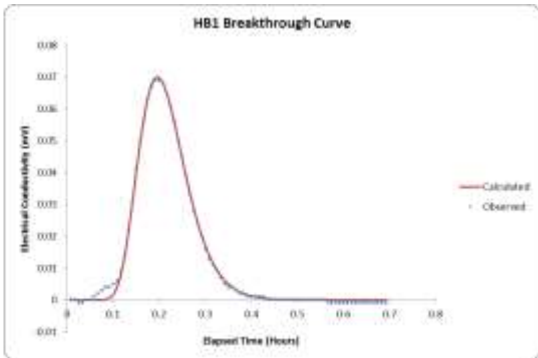
Breakthrough data were processed in VelProbe (2.2.2 or 3.0) (Schillig, 2012) to obtain v_{meas} and measured flow angle, α (α_{meas}). The calculated data were evaluated against v_d from equations 1.2 and the α orientations (Figure 2.1) measured in the NeST, α_k. The accuracies of the tests were assessed by calculating the absolute difference between v_d and v_{meas} and α_K and α_{meas} within each replicate set. Once the average PVP measured values were obtained, the standard deviations of the replicate experiments were calculated as indications of experimental precision. Note that standard deviation is an objective way to evaluate precision, but that it most accurately reflects a population variance when large data sets are used; the data sets here were small, with only three or four values. Therefore, the standard deviation values are only approximate assessments of precision in this work (Appendix B). Experiments were repeated in triplicate to verify reproducibility.

2.4 Results and Discussion

2.4.1 Standard 6 cm PVPs for Medium-Grained Sand

PVPs with diameters of about 6-cm have been the subjects of the majority of previously reported experiments. So, this size was considered first in these experiments to verify that the methods used produced results consistent with previous work.

A)



B)

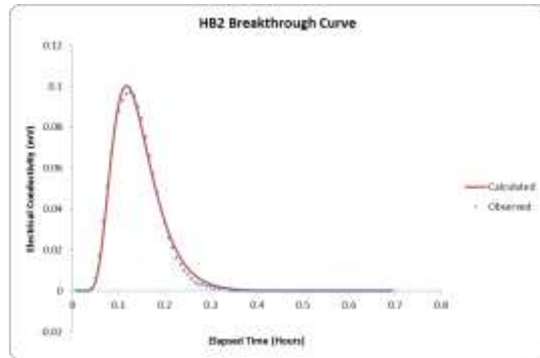
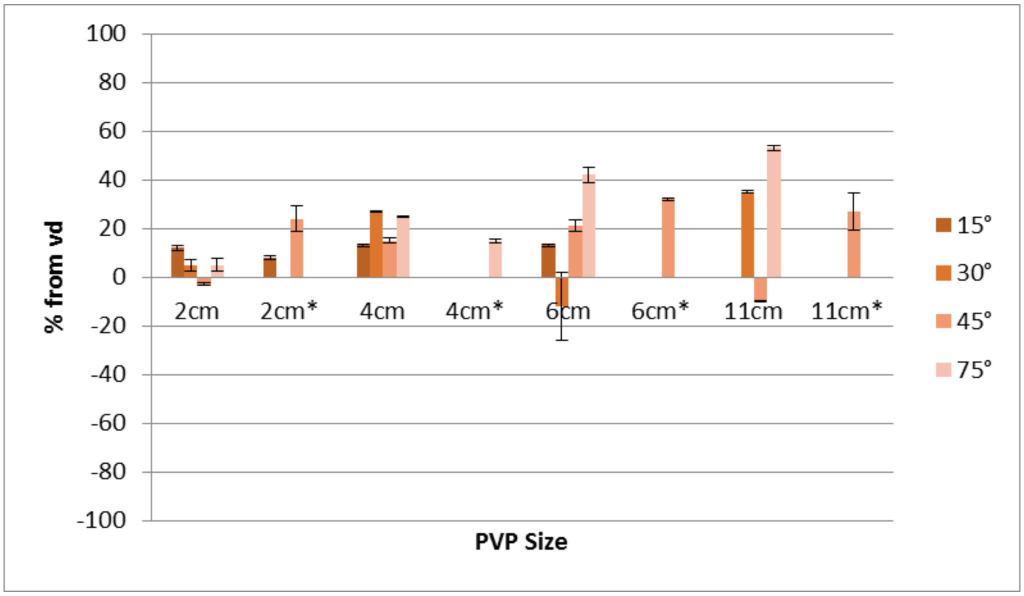


Figure 2.10: Graph of a typical breakthrough curves for the 6 cm PVP on (A) half-bridge (HB) 1 when α is 45°. Graph from experiment 03262013_6 cm_1706_medium sand_45_1gL_0.5. (B) Graph of typical breakthrough curve for the 6-cm PVP on HB2 when α is 45°. Graph from experiment 03262013_6cm_1706_medsand_45_1gL_0.5 (Appendix C).

A small but noticeable hump preceded many of the PVP breakthrough curves, regardless of PVP diameter, especially on the HB1 detectors, which were the second detectors encountered by the tracer during a measurement (Figure 2.10A). The hump does not follow the modeled breakthrough curve and may indicate smaller scale flow irregularities within the tank and on the body of the PVP. In all cases, the hump represented a small fraction of the tracer mass breaking though, and so was disregarded. The modeled breakthrough curves agreed well with the majority of remaining experimental data points. For most of the breakthrough curves measured on the HB2 detectors, the modeled breakthrough curves tended to slightly overpredict the earliest and latest time data points, and underpredict the data points on the declining arms of the breakthrough curves (Figure 2.10B). These deviations were again quite small and exerted no important effect on the estimated apparent velocity obtained in the fitting process.

Velocity measurements with the 6-cm PVPs in medium-grained sand showed good agreement between the v_d and v_{meas} for all but the highest α angles considered (75°, Figure 2.11A). The difference between the measured and expected values of velocities was within 20%. At the highest angle, α = 75°, the accuracy was within 50% (Figure 2.11B). This apparent loss of accuracy may have resulted, at least in part, to the tracer beginning to feel the influence of the downgradient stagnation point on the PVP surface (Figure 2.12).

A)



B)

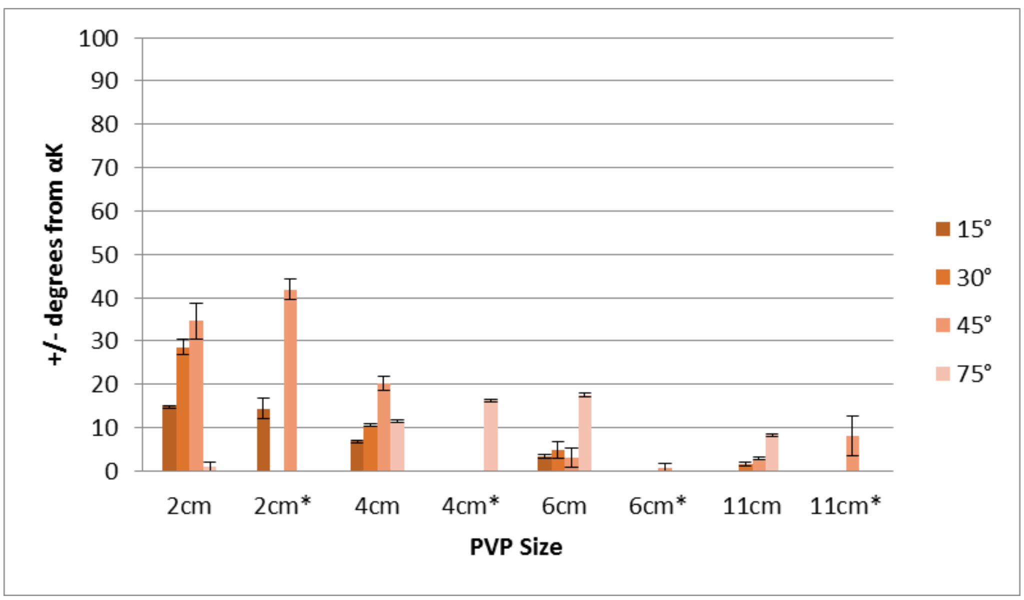


Figure 2.11: A) Plot of the relative accuracy of velocity for all PVP sizes in medium-grained sand and (B) Plot of the accuracy of direction (as $|\alpha_k - \alpha_{meas}|$*) for all PVP sizes in medium-grained sand. The * indicates the cases where a second suite of experiments were completed at an* α_K *for a specific PVP size. Error bars are plotted for each experimental suite.*

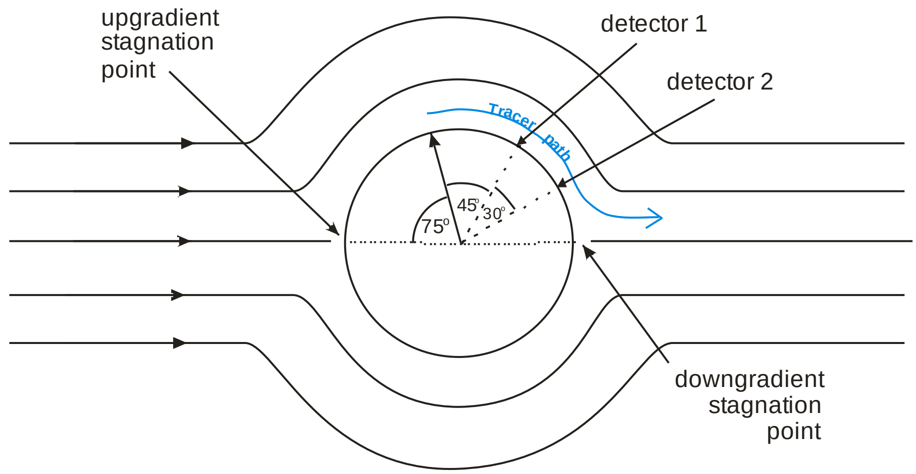


Figure 2.12: Schematic plan view of PVP showing locations of the injection port (arrow at α = 75°), and the two detectors. Also shown is the tracer path, which is seen to begin moving off the PVP surface in the vicinity of the second detector. This explains some of the accuracy loss of measurements made at the α = 75° angle.

The α_K and the α_{meas} obtained from the 6-cm PVPs were in good agreement for all experimental α angles. The differences between measured and expected values ranged from 0.7° to 18°, with the least accurate values again originating from the highest α angle experiments. The true accuracies in the estimated α angles are difficult to assess because the average flow direction through the tank is not necessarily identical to the local flow direction at the probe. Unavoidable variations in packing are expected to produce slightly tortuous flow paths through the tank. Despite these experimental difficulties, these kinds of tests represent the most controlled environments for probe performance testing.

The precision of the 6-cm PVP v_{meas} data sets was generally very good, with one standard deviation on replicates of < ±10% in all but one case (α = 30° , σ = ±29%). This anomaly is thought to have resulted from flow within the tank that varied between replications due to fluctuations in pump discharge caused by wearing of the peristaltic pump head tubing, and possibly subtle changes in sediment packing between experiments. The precision of α_{meas}, based on standard deviation of replicates, was excellent in all tests (±0.5° to ±2.3°). The results of these experiments demonstrate that the methods used in these experiments are consistent with previous work and are suitable for the investigation of PVP performance as a function of probe diameter.

2.4.2 2- and 4-cm PVPs in Medium-Grained Sand

Velocity measurements from the 4-cm PVPs in medium-grained sand showed generally good agreement between v_{meas} and v_d , i.e., within 13% to 25%. This is comparable to the results of the 6-cm PVP test results. As before, the higher α angle experiments were associated with the weakest agreements between measured and expected angles. In the worst case, however, the 4-cm PVP tests produced α angle estimates that agreed with expected values better than the corresponding 6-cm PVP tests (recall $\alpha = 75^{o}$, 6 cm PVP result was 42%). This could indicate that the 6-cm test results were due as much to uncertainties in porosity, or other experimental issues, as to inherent limitations of the probe. The relative precision of each experimental suite was good, with standard deviations ranging from ±0.5% to ±3.3%.

The 4-cm PVP tests returned α_{meas} values that compared reasonably well to α_K values with differences, ranging from 6.8° to 20°. Again, this result is comparable to the results from the 6-cm PVP tests, but the differences were consistently greater than they were in the 6-cm PVP tests, regardless of the α angle tested. This trend distinguishes these tests from earlier published PVP results, based on 6-cm PVPs, which reported α angles in agreement with expected angles to within about ±8° (Labaky *et al.*, 2007), suggesting that the smaller diameter PVP may be less accurate in measuring flow direction than the 6-cm PVPs. The precision of the α_{meas} for all experimental suites was excellent, ranging from ± 0.3° to ±1.7°.

Velocity measurements using the 2-cm PVP experiments showed good agreement between v_{meas} and v_d for all experimental α angles. Differences ranged from 3% to 12%. Standard deviations for these measured values indicated good experimental precision (± 0.7% to ± 5.4%). A different picture emerged in the estimation of the flow direction with the 2-cm PVP. Comparisons of α_{meas} and α_K in the 2-cm PVP experiments ranged from 15° to 46°, suggesting a notable loss in accuracy in measuring flow direction with the small diameter probe compared to the 6-cm probe. Standard deviations for each experiment suite were again low (±0.3° to ±4.2), indicating that precision was not affected by the probe diameters. In general, the α_{meas} are always biased smaller than α_K, for example at α_K of 15°, the average α_{meas} is 0.5°.

2.5 Sensitivity to Apparent Velocities

In one of the α_k = 15° experiments, a negative v_{meas} of -193.6 cm/day, and an α_{meas} of 179.5° were obtained (Figures 2.13A, 2.13B). This result appeared to have no physical meaning and the apparent velocities at each detector had to be in error. Prior experience indicated that constraining dispersivity in the curve fitting procedure was sometimes beneficial for convergence to appropriate apparent velocities, v_{app1} and v_{app2}. This was attempted here, holding the dispersivities in VelprobePE constant at 0.05 cm during the fitting algorithm (i.e., this parameter was not optimized). The re-evaluation yielded a v_{meas} of +198.2 cm/day, an α_{meas} of 0.65°, which made physical sense. The cost of the more meaningful outcome was a slightly poorer agreement between the calculated breakthrough curve and the observations. (Figures 2.13C, 2.13D). Apparently, very slight adjustments to the apparent velocities at the detectors were sufficient to correct the initial problem, suggesting high sensitivity of v_{meas} to the apparent velocities at the low α angle of 15°. This possibility was explored further by considering the relationship between the two parameters, given by Labaky *et al.* (2007).

$$v_{meas} = \frac{v_{apparent} \times \gamma}{2\left(cos\alpha - cos(\alpha + \gamma)\right)} \tag{2.4}$$

Differentiating equation 2.4, an expression for the desired sensitivity can be obtained,

$$\frac{dv_{meas}}{dv_{apparent}} = \frac{\gamma}{2\big(cos\alpha - cos(\alpha + \gamma)\big)} \tag{2.5}$$

Using equation 2.5, the sensitivity of v_{meas} to v_{app} can be examined as a function of the α angle (Figure 2.14).

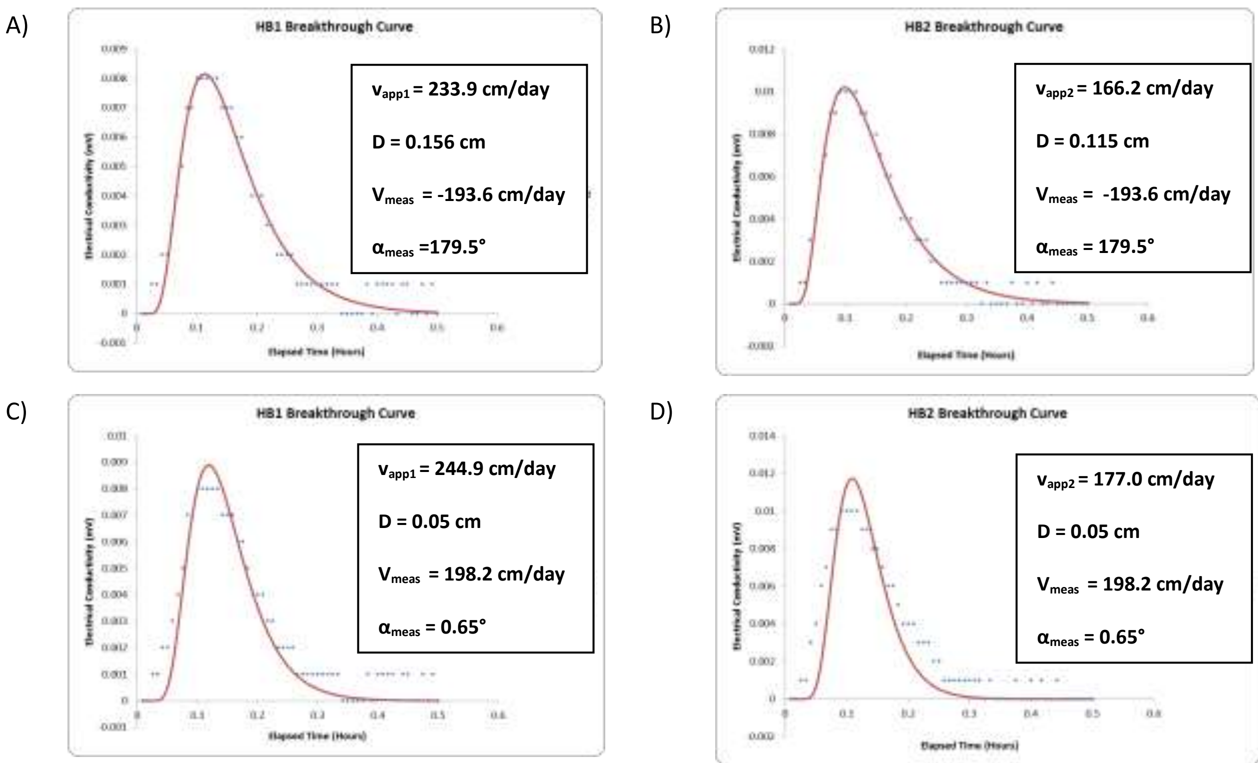


Figure 2.13: (A) Initially obtained breakthrough curve for the third 15° experiment of the second suite on HB1 for the 2-cm PVP. From experiment 05022013_2cm_1240_medsand_15_0.5gL_0.03 (Not reported in Appendix C). (B) Initially obtained breakthrough curve for the third 15° experiment of the second suite on HB2 for the 2-cm PVP. Graph from experiment 05022013_2cm_1240_medsand_15_0.5gL_0.03 (Not reported in Appendix C). (C) Breakthrough curve obtained for the re-evaluated third 15° experiment of the second suite on HB1 for the 2-cm PVP. Graph from experiment 05022013_2cm_1240_medsand_15_0.5gL_0.03 (Appendix C). (D) Breakthrough curve for the re-evaluated third 15° experiment of the second suite on HB2 for the 2 cm PVP. Graph from experiment 05022013_2cm_1240_medsand_15_0.5gL_0.03 (Appendix C).

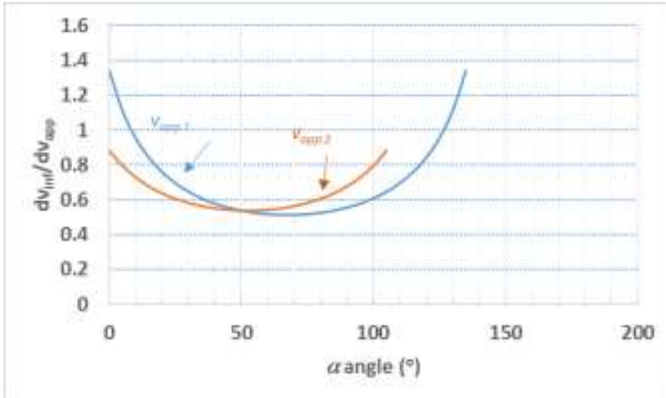


Figure 2.14: Detector apparent velocities (v_{app1} and v_{app2}) for a PVP with γ_1 = 45° and γ_2 = 75° as a function of the α angle (angle between injection port and flow direction, Figure 2.12). Note that at low and high α angles, the v_{meas} values are relatively sensitive to the apparent velocities at the detectors.

As expected, the sensitivity of v_{meas} to the apparent velocities increases at low and high angles. The magnitude of sensitivity, however, is not greater than a factor of 1.4 at any α angle. This is a useful insight, but fails to explain the dramatic change in v_{meas}, from a large negative value to a large positive one, seen here.

A closer examination of the outcomes before and after fixing the dispersivity values revealed that they were actually nearly the same, and may have simply differed in how Excel reported them. By default, Excel reports angles only in the upper semicircle of the diagrams in Figure 2.15A and Figure 2.15B. So, a vector oriented -0.5° would be reported as 179.5°, and the magnitude would be reported with a negative sign to indicate the vector was reversed in direction. Changing the dispersivity values caused a minor change in the calculated α angle of about 1° clockwise. This resulted in a vector lying in the upper hemisphere of the unit circle, and a positive reported value for the velocity magnitude resulted.

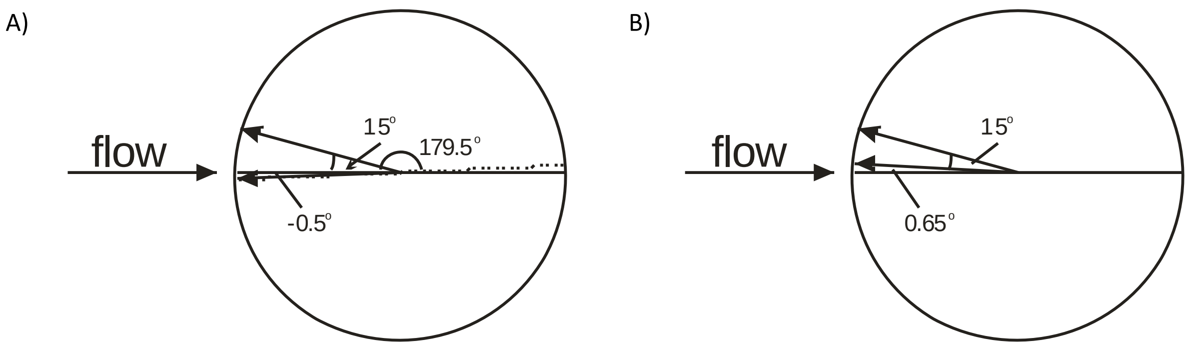


Figure 2.15: Explanation for the anomalous velocity determination with the 2-cm PVP oriented with an expected α angle of 15^o clockwise. (A) The initial analysis calculated an angle of 179.5^o measured clockwise in the diagram, which is seen to be equivalent to an angle 0.5^o counterclockwise from the incident flow direction. (B) The recalculated angle was calculated as 0.65^o clockwise, which is nearly identical. The different angles, and signs on the velocities, resulted from the default conventions in Excel (see text).

2.6 Apparent Multiple Flow Directions

The 2-cm PVP responded to the tracer injections with signals at detectors on both sides of the injection port, apparently showing flow in two directions at once. Physically, this result can occur when flow is nearly directly into the injection port, and the tracer volume is sufficient for bifurcation. The tracer injection volume in these tests was 0.1 mL, the lowest possible (with precision) with the existing equipment. In general, a low calculated α angle is expected when this situation exists. To distinguish which side of the PVP generated the signals best representing groundwater flow, two criteria were used: first, the correct detectors were located downstream of the injection port, a direction that was known in advance because of the controlled nature of these tests. This criterion would not be generally applicable in field situations. Thus, a second means of identifying the correct detectors for analysis, based on relative signal response strengths, was explored. In this case, the peak signal strengths were similar at all detectors, indicating nearly perfect bifurcation of the tracer mass. However, the total tracer mass passing over the expected downstream detectors was greater than that passing over the upstream detectors, suggesting some preference in transport pathway. Nonetheless, the consistently strong bifurcation of tracer mass indicates that the small diameter of the PVP compromises the sensitivity of flow direction measurements. Smaller injection volumes might solve this problem (Figure

2.16A), but smaller volumes mean less tracer mass and weaker signals, which creates another set of problems (Figure 2.16B).

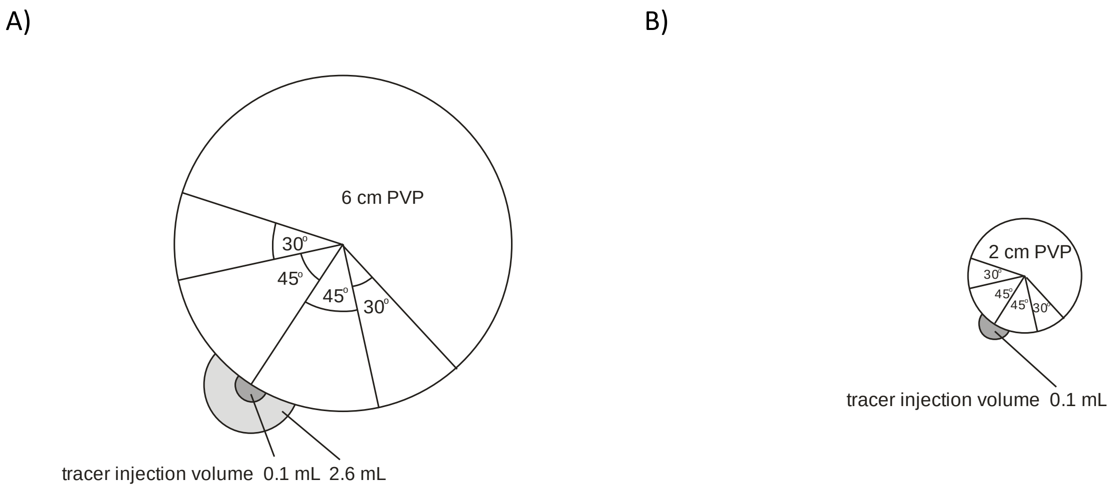


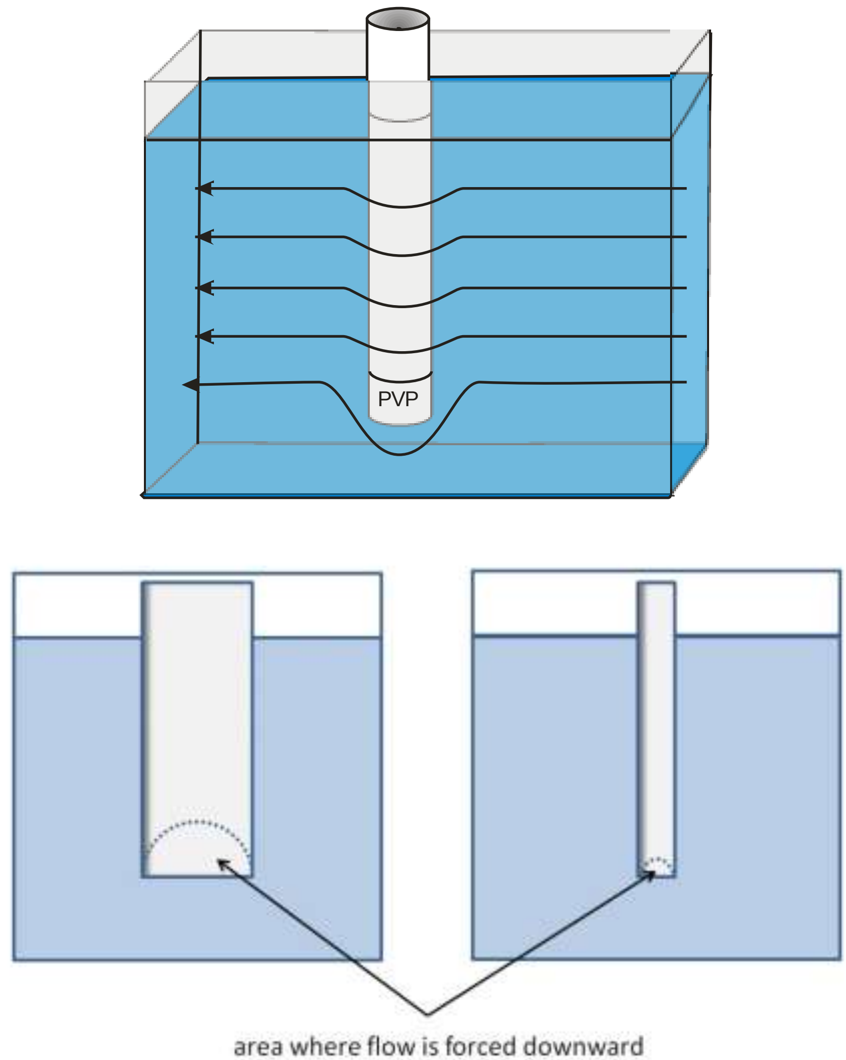
Figure 2.16: Scale drawings of tracer injection volumes on the surfaces of A) 6-cm diameter and B) 2 cm diameter PVPs. The injection of 0.1 mL of tracer volume on a 2-cm PVP occupies the same proportion of probe surface as a 2.6 mL injection on a 6-cm PVP. This proportionately large injection volume makes the 2-cm PVP more susceptible to bifurcation of the tracer mass, and less sensitive to flow direction measurements.

2.6.1 11 cm PVPs in Medium-Grained Sand

An attempt was made to evaluate the relative accuracy of v_{meas} and α_{meas} using an 11-cm PVP. A series of experiments was attempted for α_K angles of 30°, 45°, and 75°. In these tests, a strong response would typically appear in association with the lower detector on the PVP, HB6, indicating vertical flow downward (Appendix C). The NeST was setup to create a horizontal flow system, so any vertical flow was due to an unintended cause. Downward flow due to tracer density could be ruled out since similar tracer concentrations in earlier tests did not cause vertical flow. The hypothesis for this was that the downward flow resulted from diverted flow, possibly caused by the PVP itself, due to its large size (Figures 2.17A, 2.17B). To establish that a physical cause existed for the downward diversion of flow, the tank was repacked with the PVP resting on the floor of the NeST, preventing, or at least severely limiting, downward flow. With this configuration, the subsequent experiments were completed with much weaker indications of vertical flow, supporting the flow redirection hypothesis.

Placing the PVP on the floor of the NeST helped alleviate the vertical flow problem, but not eliminate signals at HB6 (the lower detector for vertical flow) in all experiments. The 11-cm PVP might have been more successful in a larger NeST system with more space between the PVP and the tank walls, i.e., minimizing the influence of boundary effects. Nevertheless, this work yielded an insight useful for field applications. To circumvent vertical flow redirection on the PVPs, a casing length of at least several PVP diameters in length, should be attached to the base of PVPs so that any vertical flow diversion occur well away from the detectors.

A)



B)

Figure 2.17: A) Oblique angle view of flow around a terminal PVP. Above the probe flow is diverted around the casing horizontally, but below the probe flow is diverted downward. B) Diagram showing that the larger the diameter of the PVP, the greater the area on the probe experiencing downward flow.

The 11-cm PVP experiments generally produced v_{meas} values that were the furthest from expected values compared to experiments with the other PVP sizes (Figure 2.11, Appendix C). The relative differences between the measured and expected velocities ranged from 10% to 53%. This may in part have been due to the strong responses on the vertical detector, HB6, in some of the tests (second 45° and 75° suites, and an attempted 15°). In these cases, a relatively small fraction of the tracer mass was available for detection on the horizontal detectors, and the opportunity for small biases to occur was therefore greater. However, even in the experiments where vertical flow was minimized (series at 30°, 45°, and 75°) relatively large differences between v_{meas} and v_d persisted (Figures 2.11A and 2.11B). The weaknesses in performance here may have been due to the PVP being oversized for the NeST. In addition, some tests may have been adversely affected by unrecognized declines in the tank water levels by changing the cross sectional area available for flow in equation 2.3 due to evaporative losses between tests. Such losses were noted at the time of the experiments, but were thought to be minor at the time.

In contrast to the difficulties experienced with the estimation of velocity magnitudes, the estimated α angles matched expectations within 2^o to 8^o of expected values, which was better than the 6-cm, 4-cm, and 2-cm PVPs. The accuracy of α_{meas} is, therefore, expected to increase with increased PVP diameter size. The standard deviation of α angles ranged from ±0.3° to ±4.7°, continuing to show the high precision of PVP measurements.

2.6.2 Fine-Grained Sand

A series of experiments were completed with the 6-cm, 4-cm and 2-cm PVPs at known α angles of 15°, 30°, 45°, and 75° in fine-grained sand. As before, experiments were repeated in triplicate to verify that the results are representative of conditions within the NeST tank.

2.6.3 Standard 6 cm PVPs in Fine-Grained Sand

In fine sand, the 6-cm PVPs returned water velocities within 4% to 24% of v_d (Figure 2.18A). The relative precision ranged from ±1.1% to ±4.6% for v_{meas}. The α_{meas} ranged from 1.6° to 14° of α_k with a precision of ±0.6° to ±3.4° (one standard deviation)(Figure 2.18B). In most tests the v_{meas} was higher than v_d, suggesting a bias in the v_d, possibly related to error in the porosity value used to calculate v_d. The fine sand findings were similar to the medium-grained sand experimental results.

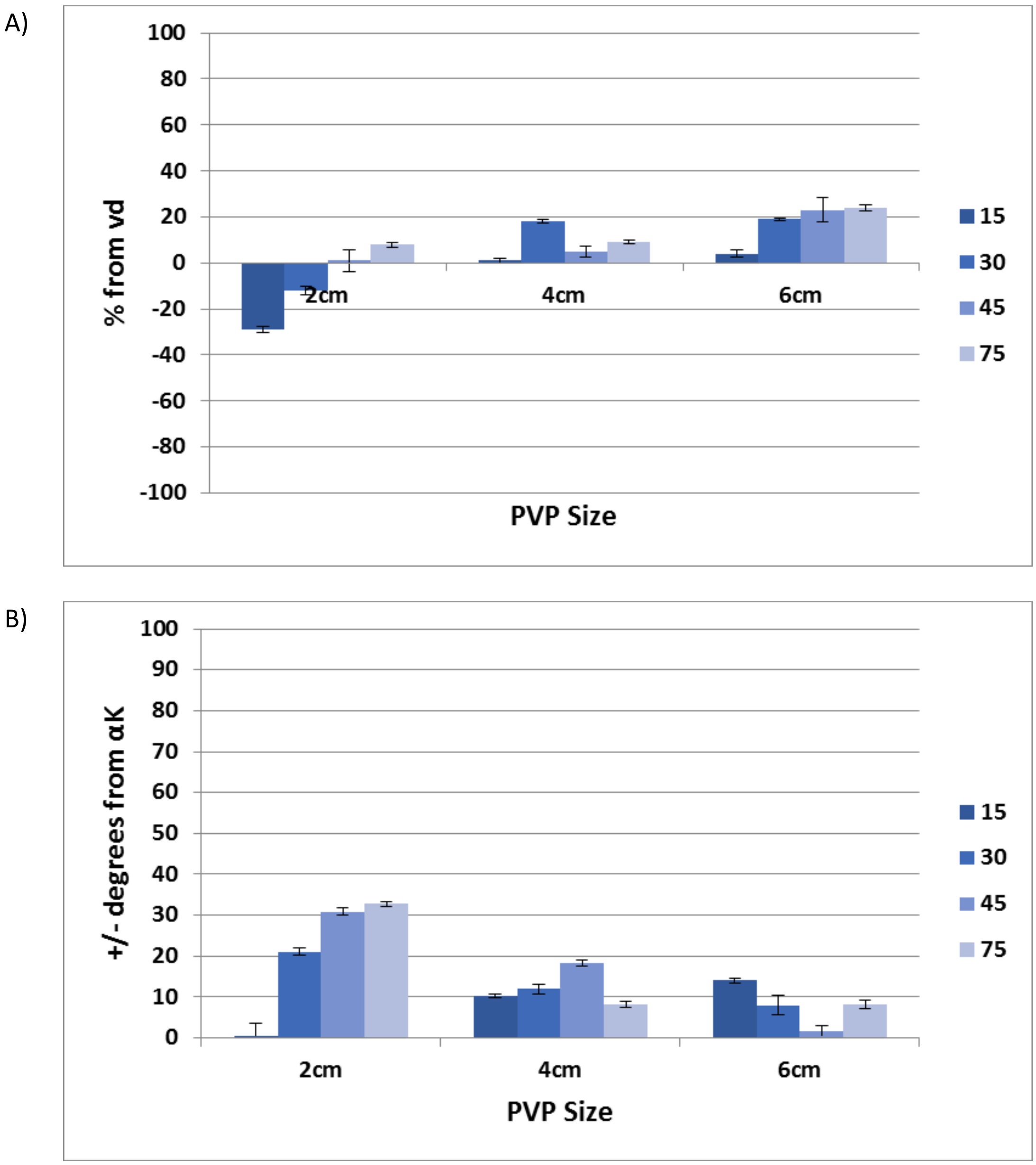


Figure 2.18: (A) Plot of the relative accuracy of velocity for all PVP sizes in fine-grained sand. (B) Plot of the relative accuracy of direction for all PVP sizes in fine-grained sand. Error bars are plotted for each experimental suite.

2.6.4 2- and 4-cm PVPs in Fine-Grained Sand

The 2-cm PVPs performed well compared to the 6-cm probes, although flow directions were less convincingly accurate in the smaller probes. The v_{meas} values were found to be within ±1% to ±29% of v_d. with a precision of ±0.5% to ±5.4% (Figure 18A). The values of α_{meas} were within ±8.3° to ±33° of α_k with precision of ±0.7° to ±2.2° (Figure 18B). The trend of v_{meas} being higher than v_d, did not apply to the 2-cm PVP data set, possibly because a more representative value of porosity was used to calculated v_d.

The 4-cm PVPs were found to behave in a fashion similar to the 6-cm PVPs. The v_{meas} values were found to be within ±1% to ±18% of v_d (Figure 2.18A), and the α_{meas} values were within ±8.1° to ±18° of α_k. The relative accuracies ranged from ±0.8% to ±2.3% for v_{meas} and ±0.4° to ±1.3° for α_k (Figure 2.18B). As with the 6-cm PVPs, the v_{meas} values tended to be larger than v_d, suggesting a possible bias in the v_d originating with the porosity measurement.

2.7 Conclusions

In these experiments, the accuracy of velocity for all data sets is within ±30% of v_d, which is largely explainable by the uncertainty in the porosity that existed in the NeST at the times of the experiments. Most importantly, the relative accuracy of α_{meas} appeared to decrease with decreasing size of PVP. This trend is noteworthy as it was consistent in both the medium- and fine-grained sand experiments.

The α_{meas} do not appear to be affected by the grain sizes of the two experimental sand media. The accuracy of α_{meas} increased with PVP diameter. PVP data collected by Labaky (2007) were within ±8° of α_K. The deviation from α_K was generally ±20° for PVPs 4 cm and larger. This deviation was larger in the 2-cm PVP, being 8° to 45°.

Experiments involving 11-cm diameter PVPs exhibited significant vertical flow when the probes were installed above the floor of the NeST. The degree of vertical flow was greatly reduced by positioning the PVP on the base of the tank, indicating flow redirection, rather than density driven flow, was responsible for much of the observed effect. Boundary effects may have influenced the v_{meas} values. Therefore, future tests involving 11-cm diameter probes, or larger, should be conducted in aquifer simulators with greater dimensions.

PVP diameter size was found to affect both the measurements of groundwater speed and direction. The most noticeable trend found was that as the diameter of a PVP is decreased, the accuracy of the groundwater direction measurement decreases. Another notable trend was that as the diameter of the PVP decreased, the velocity measurements accuracy slightly increased. Therefore, for PVP field applications, users should consider PVP sizes as a variable that is useful in optimizing the quality of measurements.

2.8 References

Alden, A. S. and C. L. Munster. 1997. Field Test of the In Situ Permeable Ground Water Flow Sensor. *Ground Water Monitoring & Remediation* 17 no. 4: 81-88.

Annable, M. D., Hatfield, K., Cho, J., Klammler, H., Parker, B.L., Cherry, J.A., and P.S.C. Rao. 2005. Field-Scale Evaluation of the Passive Flux Meter for Simultaneous Measurement of Groundwater and Contaminant Fluxes. *Environmental Science & Technology* 39 no. 18: 7194-7201.

Berg, S. J. and R. W. Gillham. 2010. Studies of water velocity in the capillary fringe: the point velocity probe. *Ground Water* 48, no. 1: 59-67.

Bianchi, M., Zheng, C., Tick, G.R., Gorelick, S.M. 2011. Investigation of small-scale preferential flow with a forced-gradient tracer test. *Ground Water* v. 49, no. 4, 503–514.

Bowen, I. R., Devlin, J.F., and P.C. Schillig. 2012. Design and Testing of a Convenient Benchtop Sandbox for Controlled Flow Experiments. *Ground Water Monitoring & Remediation* 32, no. 4: 87-91.

Clark, I. D. and P. Fritz. 1997. *Environmental Isotopes in Hydrogeology*. Boca Raton, CRC Press/Lewis Publishers.

Devlin, J.F., Schillig, P.C., Bowen, I., Critchley, C.E., Rudolph, D.L., Thomson, N.R., Tsoflias, G.P., and J.A. Roberts. 2012. Applications and implications of direct groundwater velocity measurement at the centimetre scale. *Journal of Contaminant Hydrology* 127, no. 1-4: 3-14.

Devlin, J.F. 2014. Hydrosieve v. 1.1.

Fetter, C.W. 2001. *Applied Hydrogeology – Fourth Edition*. Prentice Hall, Upper Saddle River, New Jersey.

Gierczak, R.F.D., Devlin, J.F., Rudolph, D.L. 2007. Field test of a cross-injection scheme for stimulating in situ denitrification near a municipal water supply well. *Journal of Contaminant Hydrology* v. 89, 48-70.

Guthrie, M. 1986. Use of a Geo Flowmeter for the Determination of Ground Water Flow Direction. *Ground Water Monitoring & Remediation* 6 no. 2: 81-86.

Halvey, E., Moser, H., Zellhoffer, O., and A. Zuber. 1967. Borehole Dilution Techniques: A Critical Review. Proceedings of the symposium on Isotopes in Hydrology. Vienna, Austria, I.A.E.A: 531-564.

Hatfield, K., Annable, M., Cho, J., Rao, P.S.C., and H. Klammler. 2004. A direct passive method for measuring water and contaminant fluxes in porous media. *Journal of Contaminant Hydrology* 75 nos. 3–4: 155-181.

Kasnavia, T., Vu. D., and Sabatini, D.A. 1999. Fluorescent Dye and Media Properties Affecting Sorption and Tracer Selection. *Ground Water* 37 no. 3: 376-381.

Kearl, P. M. 1997. Observations of particle movement in a monitoring well using the colloidal borescope. *Journal of Hydrology* 200 nos. 1–4: 323-344.

Kempf, A., Divine, C.E., Leone, G., Holland, S., and J. Mikac. 2013. Field performance of point velocity probes at a tidally influenced site. *Remediation*, Winter, DOI: 10.1002/rem, 37-61.

Kerfoot, W. B. and V. A. Massard. 1985. Monitoring Well Screen Influences on Direct Flowmeter Measurements. *Ground Water Monitoring & Remediation* 5 no. 4: 74-77.

Klammler, H., Hatfield, K., and M.D. Annable. 2007. Concepts for measuring horizontal groundwater flow directions using the passive flux meter. *Advances in Water Resources* 30 no. 4: 984-997.

Labaky, W., Devlin, J.F., and R.W. Gillham. 2007. Probe for Measuring Groundwater Velocity at the Centimeter Scale. *Environmental Science & Technology* 41, no. 24: 8453-8458.

Labaky, W., Devlin, J.F., and R.W. Gillham. 2009. Field comparison of the point velocity probe with other groundwater velocity measurement methods. *Water Resources Research* 45, DOI: 10.1029/2008WR007066.

LeBlanc, D.R., Garabedian, S.P., Hess, K.M., Gelhar, L.W., Quadri, R.D., Stollenwerk, K.G., and W.W. Wood. 1991. Large-scale natural gradient tracer test in sand and gravel, Cape Cod, Massachusetts: 1. Experimental design and observed tracer movement. *Water Resources Research* 27 no. 5: 895-910.

Mackay, D. M., Freyberg, D.L., Roberts, P.V., and J.A. Cherry. 1986. A natural gradient experiment on solute transport in a sand aquifer: 1. Approach and overview of plume movement. *Water Resources Research* 22 no. 13: 2017-2029.

Melville, J. G., Molz, F.J., and O. Güven. 1985. Laboratory Investigation and Analysis of a Ground-Water Flowmeter. *Ground Water* 23 no. 4: 486-495.

Momii, K., Jinno, K., and F. Hirano. 1993. "Laboratory studies on a new laser Doppler Velocimeter System for horizontal groundwater velocity measurements in a borehole. *Water Resources Research* 29 no. 2: 283-291.

Ogilivi, N. A. 1958. Electrolytic method for the determination of the ground water filtration velocity (in Russian). In *Bulletin of Science and Technology News*, No. 4, Moscow, Russia: Gosgeoltehizdat.

Patterson, B. M., Annable, M.D., Bekele, E.B., and A.J. Furness. 2010. On-line groundwater velocity probe: Laboratory testing and field evaluation. *Journal of Contaminant Hydrology* 117 nos. 1–4: 109-118.

Pitrak, M., Mares, S., and M. Korb. 2007. A Simple Borehole Dilution Technique in Measuring Horizontal Ground Water Flow. *Ground Water* 45 no. 1: 89-92.

Robertson, W. D. and J. A. Cherry 1989. Tritium as an indicator of recharge and dispersion in a groundwater system in central Ontario. *Water Resources Research* 25 no. 6: 1097-1109.

Schillig, P.C. 2012. Hydrogeologic Control on Bioactive Zone Development in Biostimulated Aquifers. P.h.D. Thesis. University of Kansas, Department of Geology.

Sudicky, E. A. and W. A. Illman. 2011. Lessons Learned from a Suite of CFB Borden Experiments. *Ground Water* 49 no. 5: 630-648.

Tsang, C., Hufschmeid, P., and F.V. Hale. 1990. Determination of fracture inflow parameters with a borehole fluid conductivity logging method. *Water Resources Research* 26 no. 4: 561-578.

3.0 PVP Experiments in a Gravel Medium

3.1 Abstract

A series of point velocity probe (PVP) experiments was conducted in a bench-top aquifer simulator packed with gravel. Previous work had shown that 6-cm diameter PVPs were capable of making groundwater velocity determinations in gravel and gravel-rich sediments, in laboratory testing and in the field, respectively. The purpose of this work was to further that work by assessing the effect of PVP size on velocity measurement accuracy and precision in a well-sorted gravel medium. The gravel used in these experiments comprised 2-mm to 10-mm diameter grain sizes with a porosity determined gravimetrically to be 42%. PVP performance in gravel was hypothesized to be very sensitive to probe diameter, because the scale of the pores in gravel approach the scale of the probe sensor system, leading to ambiguity in the physical meaning of the velocity measurements, (i.e., average velocities *vs*. velocities in individual pores). Nonetheless, the work showed that PVPs can be used to obtain reasonable estimates of groundwater velocity in gravel media. Velocity magnitudes obtained with the 6-cm PVP were within 11% of expected values, but flow directions were less certain, regularly falling within only 50^{o} of expected values. Velocity magnitudes measured with the 2-cm PVPs agreed less well with expected values (± 39%), but the expected values were themselves subject to unexpected uncertainties in those experiments. These preliminary experiments indicated that flow directions were not reliably determined with the 2-cm PVPs in gravel. Nevertheless, further evaluation of PVPs in gravel, particularly small diameter units, is recommended, since even the most problematic measurements in these tests could still be of practical value in some cases.

3.2 Introduction

Measurements of groundwater flow direction and magnitude, using point velocity probes (PVPs) in sandy sediments, are reasonably accurate and reproducible in noncohesive saturated sediments, from fine sand to sandy gravel (Labaky *et al*., 2007; Devlin *et al*., 2009; 2012; Berg and Gillham, 2010; Schillig *et al*., 2011; Bowen *et al*., 2012). PVPs are not designed for use in smaller grained, cohesive sediments since borehole collapse may be incomplete, or not occur at all in these media, and the necessary contact between the probe surface and the aquifer cannot be assured. At the other end of the grain-size scale, - gravel - , little data exist with which to evaluate the limits of PVP performance. Performance declines may be expected in coarse gravel because the pore sizes may approach the scale of the probe sensing system, leading to questions concerning the physical meaning of the velocity being measured; is it an average velocity over many pores or a velocity dominated by one or two pores? The question can be important because where gravel aquifers exist, groundwater flow rates can be substantial. Similarly, continuous seams or strata of gravel, even thin gravel features, can act as conduits for contaminant transport that greatly reduce transport times to receptors.

Useful, and apparently accurate, PVP velocity data were obtained from a sandy gravel till deposit at the Woodstock site in Ontario, Canada, providing field evidence that the probes could be used in coarse-grained sediments (Devlin *et al*., 2012). In that case, the PVPs returned velocity estimates of 2,500 cm/day, or greater, an order of magnitude greater than expectations. These estimations were later validated with a natural gradient tracer test.

Schillig *et al.* (in press) found in laboratory tests that PVPs could be used effectively in gravel sediments but discovered that the measurements were more sensitive to secondary effects, such as density driven flow, than they were in sand. In order to better define the limits of PVP usage in gravelly sediments, and to extend the work of Schillig *et al.* (in press), this work was undertaken with the specific purpose of evaluating the effects of probe diameters on PVP performance in a well-sorted gravel medium in the controlled setting of a NeST (Bowen *et al*., 2012) benchtop aquifer simulator.

3.3 Methods

PVP experiments were conducted in NeST aquifer simulators, as described in Chapter 2, for the fine-grained and medium-grained sand cases. Briefly, gravel was wet packed into the tank and a hydraulic gradient was applied across the tank to simulate groundwater flow through the saturated gravel. Before conducting a PVP experiment, water was circulated in the tank 4 to 8 hours, to establish a stable baseline on all of the PVP detectors. This stabilization period was notably longer than that required in the sand experiments (1 to 2 hours). The expected velocity (v_d) was estimated for each experiment from:

$$v_d = \frac{Q}{\varphi A} \tag{3.1}$$

where Q is the discharge through the tank (L^3T^{-1}), φ is porosity (dimensionless), and A is the cross sectional area of the tank (L^2). A porosity of 42% was used in the calculation, which was obtained gravimetrically by wet packing a 250 mL beaker with the same gravel used in the NeSTs, and later drying the material for weighing (Table 3.1). The porosity was then calculated from:

$$\varphi = \frac{\left(M_{wet} - M_{dry}\right)}{\rho_w V_{tot}} \tag{3.2}$$

where M_{wet} is the mass of wet gravel medium (M), M_{dry} is the mass of the dry gravel medium (M), ρ_w is the density of water (ML^{-3}), and V_{tot} is the volume of the wet gravel medium (L^3).

A mechanical sieve analysis was completed with a gravel sample with an approximate weight of 3,000 g. Sieve analysis data were evaluated using the HydroSieve v. 1.1 (Devlin 2014) program, which includes K estimation using the Chaupis (2004) method for gravel media. According to Chapuis,

$$K = 10^{1.291e-0.6435}[d_{10}]^{10^{0.5504-0.2937e}} \tag{3.3}$$

where

$$e = \frac{\varphi}{1-\varphi}$$

and φ is the effective porosity (= 0.42), and d_{10} was found to be 5.2 mm from the analysis of HydroSieve 1.1 (see Figure 3.1). The hydraulic conductivity of the gravel was calculated to be 75.3 cm/s. The gravel was uniform, low in fines, and comprised 80% fine gravel and 20% medium gravel (Figure 3.1).

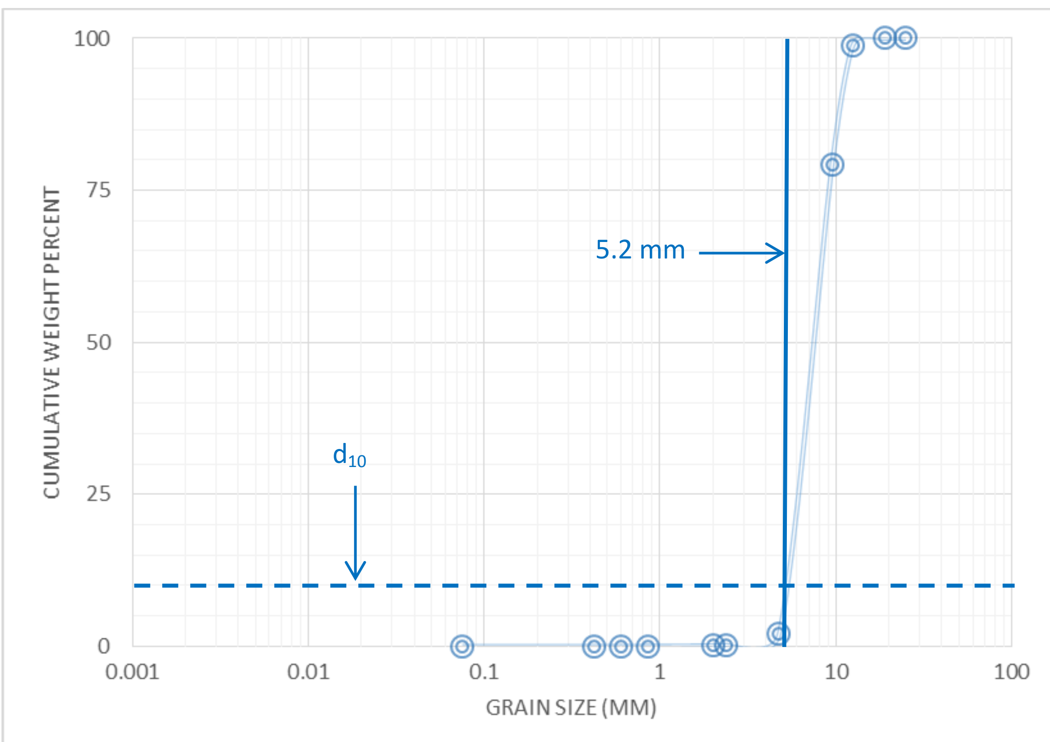


Figure 3.1: Grain size distribution graph for gravel used in NeST. The gravel contains 80% fine gravel and 20% medium gravel. Plotted with HydroSieve v 1.0 (Devlin, 2014) with d_{10} plotted with dashed and 5.2 mm size plotted with solid line.

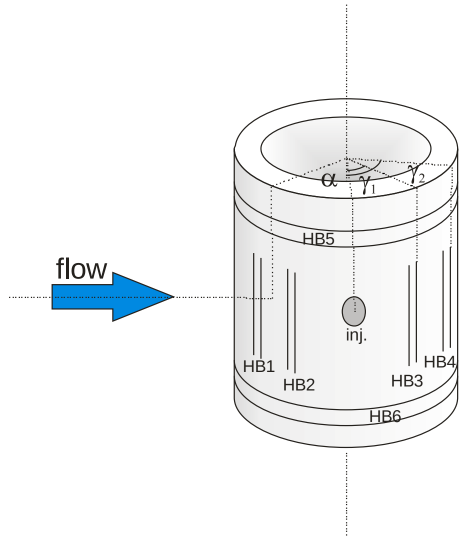


Figure 3.2: Schematic of a PVP showing the measured angle α, the design angles γ_1 and γ_2, the injection port (inj.), and the 6 detectors (one wire pair each) available on the units used in this work (HB1 through HB6). Ideally, with flow moving in the direction indicated above, the tracer injected at inj. would be transported over HB3 and HB4 to provide a horizontal velocity estimation. Upward flow would carry the tracer over HB5, and downward flow would carry the tracer over HB6.

A series of experiments was conducted to optimize the data collection for horizontal velocity estimation, using 6-cm PVPs in gravel. The work was aimed at determining the conditions that would minimize the responses on the vertical detectors, due to buoyancy of the tracer solution, and maximize the signals on the horizontal detectors. Adjustments were made systematically to tank water velocity, injection tracer concentration, injection volume, and the known α orientation (α_K). The smallest PVP size, 2-cm diameter, was subsequently tested in a similar fashion.

Table 3.1: Results for porosity measurement of gravel media

sample	dry beaker (g)	beaker with dry sample (g)	beaker with saturated sample (g)	media mass (g)	sample volume (cm^3)	ρ_b (g/cm^3)	void water (g)	φ	average φ
G1	83.75	309.09	372.13	225.34	150	1.50	63.04	0.420	0.423
G2	90.99	304.18	365.27	213.19	150	1.42	61.09	0.407	
G3	75.55	304.48	370.62	228.93	150	1.53	66.14	0.441	

3.4 Results and Discussion

3.4.1 6-cm PVP

Effects of buoyancy forces on flow in gravel media: The first gravel experiment was conducted with a water velocity (v_d) of 200 cm/day, estimated from equation 3.1. The test was conducted with a discharge rate of approximately 50 mL/min and an α orientation of 15°, using a PVP with a diameter of 6 cm (Figure 3.2).

The 200 cm/day velocity was selected for the purpose of comparability between similar experiments involving 6-cm PVPs in fine- and medium-grained sand (Gibson, in preparation; Walter, in preparation). A tracer consisting of 0.5 mL of 0.25 g/L of NaCl was adopted for the tests, and was within the range of successful prior tests. Following the tracer injection, a small signal was received on the bottom vertical detector, HB6 (Figure 3.3), but no signals were received on any of the horizontal detectors; responses were expected at HB1 and HB2. The estimated vertical velocity was 912 cm/day based on a breakthrough time of approximately 0.05 hours (1.5 minutes) on HB6 at a distance of 1.9 cm. A replication of the experiment produced the same result.

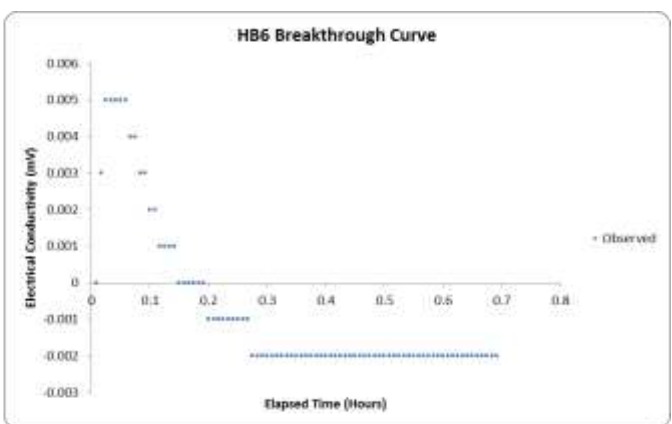


Figure 3.3: Results of 6-cm PVP experiment in gravel at α orientation of 15° with targeted tank velocity of 200 cm/day on HB6 (06192013_6cm_1303_gravel_15_0.25gL_0.5).

The lack of response on the horizontal detectors might have resulted from one of several causes. First, tracer density driven flow could have dominated the transport and obscured any horizontal flow detectable by the PVP in the gravel medium. Second, the low α angle (15^{o}) may have been problematic, as discussed in Chapter 2. Third, signal strength at all detectors were quite weak, raising the possibility that the injected tracer mass did not remain on the probe surface during injection, moving off the surface either by dispersion or by advection imparted by the injection itself. This could easily happen if the injection port were aligned with a large open pore.

To determine if vertical flow was resulting from buoyancy forces in the saturated gravel, the horizontal gradient was calculated using Darcy's Law, based upon the NeST cross-section area (936 cm^2), flow rate (206.7 mL/min or 297,600 cm^3/day), and an the estimated hydraulic conductivity (K) for the gravel (75.3 cm/s). The horizontal hydraulic gradient (i_H) in the tank was estimated to be 2.17E-04. The vertical equivalent freshwater hydraulic gradient $(dH_{i,f}/dz)_v$ induced by the density of the saline tracer can be estimated using the method described by Schillig *et al.* (in press). With a tracer concentration of 250 mg/L, and an approximate room temperature of 20 ^{o}C, $(dH_{i,f}/dz)_v$ was estimated to be 1.9E-04. The percent of vertical flow (*%VF*) can be calculated to be about 47% from the horizontal gradient (i_H) and $(dH_{i,f}/dz)_v$ using equation 3.4:

$$\%VF = \frac{\left(\frac{dH_{i,f}}{dz}\right)_v}{\left(\frac{dH}{dx}\right)_H + \left(\frac{dH_{i,f}}{dz}\right)_v} \times 100\% \qquad (3.4)$$

Horizontal velocity estimates made with PVPs of the kind used here may be noticeably affected if the fraction of vertical flow exceeds 30%. In this case, the vertical flow due to buoyancy effects was sufficiently pronounced in these experiments to weaken or eliminate signals on the horizontal flow detectors. For example, the signals on the horizontal detectors, particularly the one furthest from the injection port, may represent partial breakthrough curves as the tracer grazes the detector without passing completely over it (Figure 3.4). This could result in the calculation of incorrect apparent velocities, from which the groundwater velocities are calculated.

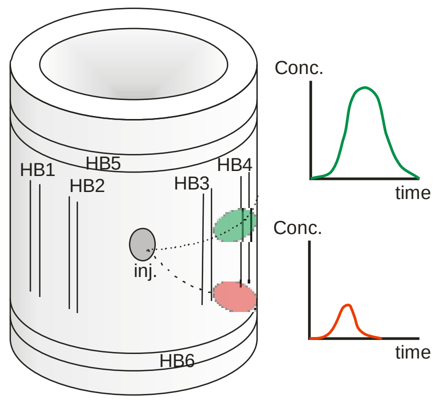
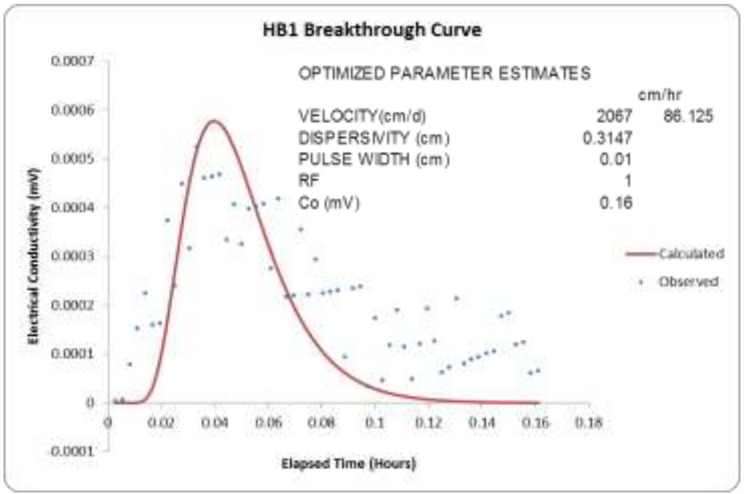


Figure 3.4: Illustration of two tracer pulses following paths that encounter HB4. The green pulse travels over the detector normally, giving an accurate value of v_{app2}*. The red pulse leaves the detector vertically before completing a horizontal breakthrough curve. In this hypothetical case, a positive bias results on the estimated velocity measured at HB4 (Schillig, in press).*

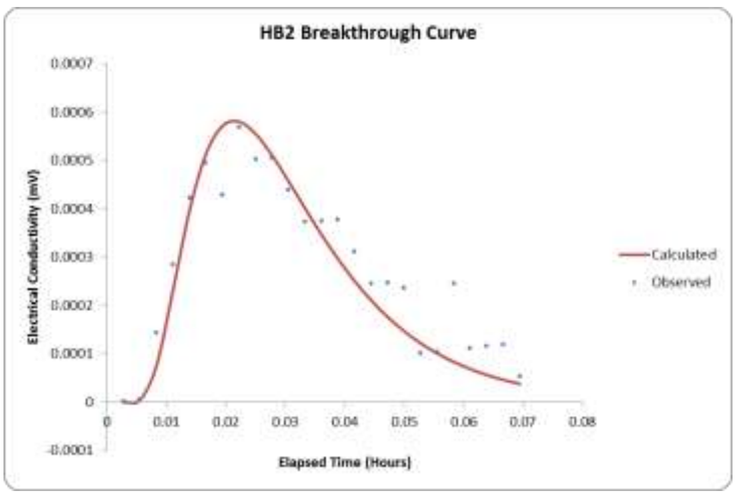
In the next experiment, the flow angle was adjusted to 45°, to eliminate any errors associated with low-angle velocity measurements, and water velocity was increased to 1,200 cm/day, to overwhelm any buoyancy effects from the tracer (Schillig *et al.* in press).

As anticipated, the extreme horizontal velocity imposed in this test resulted in PVP responses on the expected detectors, HB1 and HB2, and no response on the lower detector, HB6. The signals continued to be weak, however, compared to what was detected in the sandy media - on the order of 100 times weaker (Figure 3.5).

A)



B)



C)

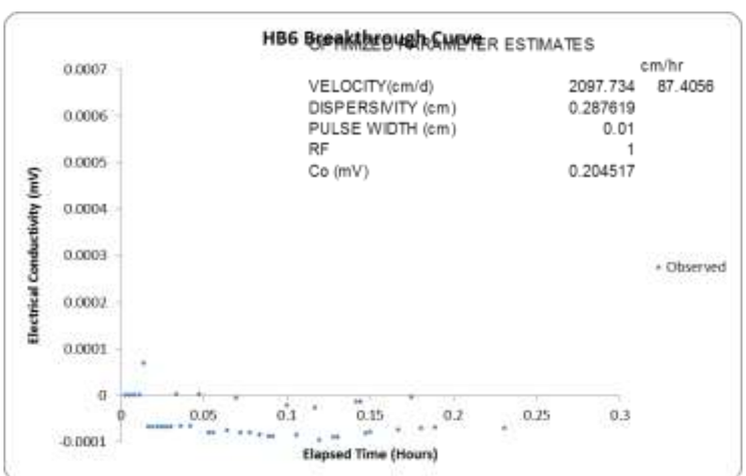


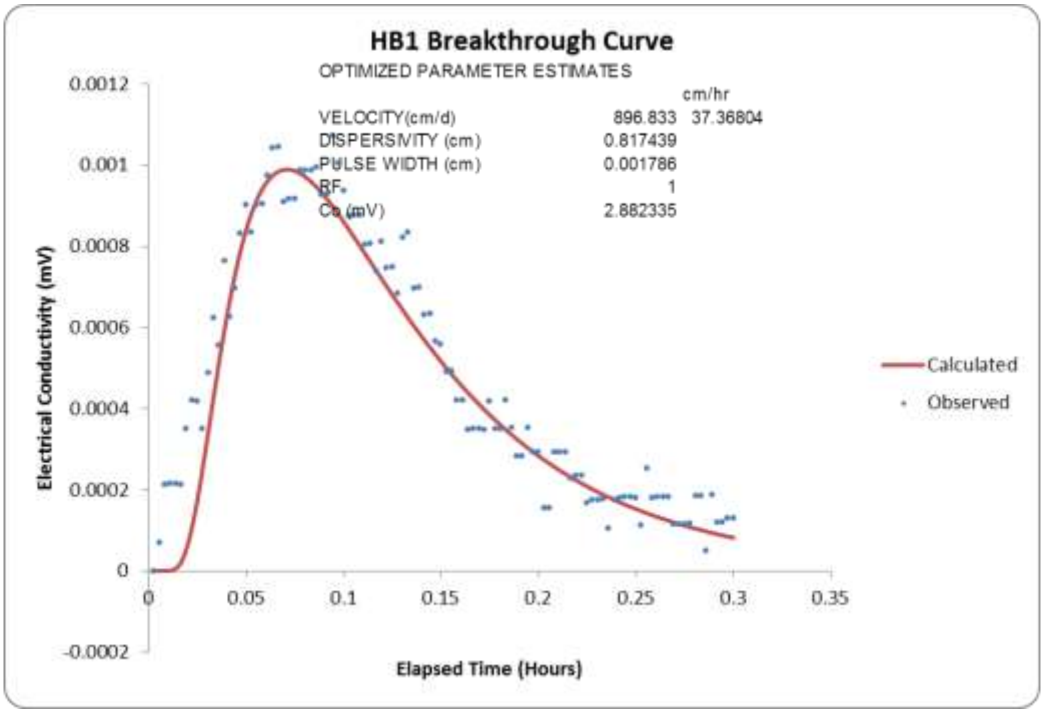
Figure 3.5: Breakthrough curves for HB1 (A) and HB2 (B) of 6 cm PVP experiment in gravel with tank velocity of approximately 1,200 cm/day, injection concentration of 0.25g/L, injection volume of 0.5mL, and an alpha orientation of 45°. Note there is no breakthrough curve on HB6 (C) Signal on HB6, no breakthrough curve was observed based upon the distribution of the electrical conductivity measurements through time (06242013_6cm_1703_gravel_0.25gL_0.5).

A higher tracer concentration might be required to obtain a higher quality signal based upon the results of the experiment. With this in mind, the tracer concentration was increased to 0.5 mg/L. Also, as an additional check on the effect of flow rate on signal quality at the horizontal flow detectors, the flow rate was adjusted downward to 750 cm/day.

As expected, horizontal velocities continued to be measurable at detectors HB1 and HB2. However, at the lower flow rate a clear signal also reappeared on the lower detector, HB6, confirming the role of buoyancy forces in driving vertical tracer movement. Though the horizontal detector signals remained weak compared to those in the sand tank tests (more than 10X weaker, see Chapter 2), they were up to twice the strength of the previous gravel tank tests due to the higher tracer concentration. These findings support the hypothesis that the weak signals were caused primarily by tracer mass leaving the probe surface during the injection phase.

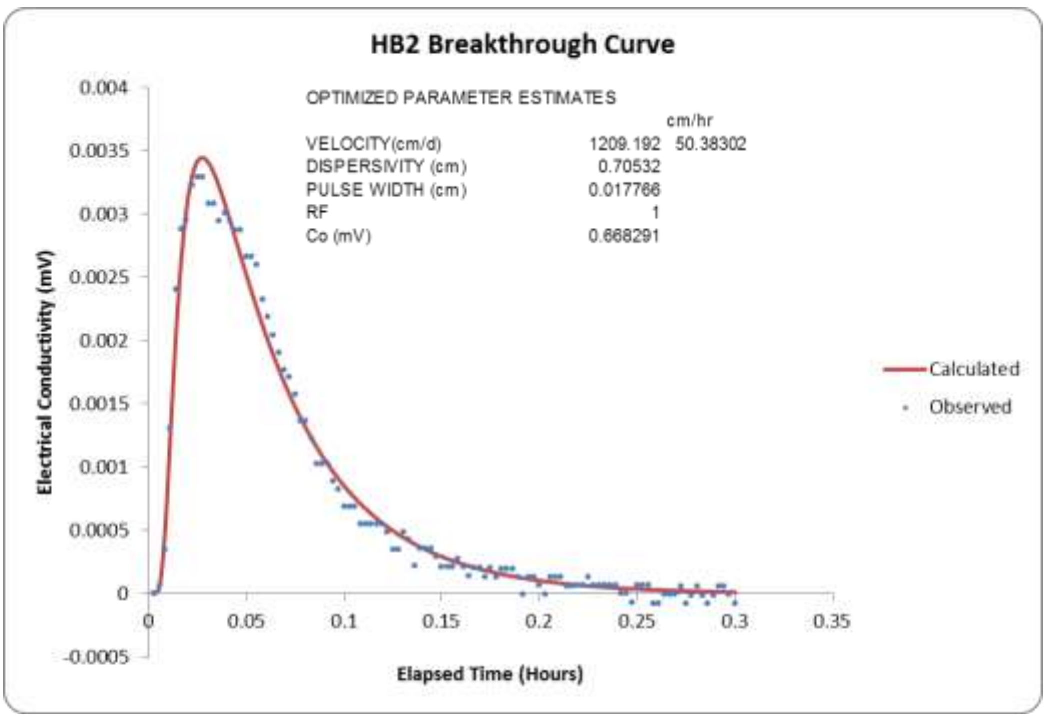
Subsequent experiments were completed in quadruplicate using the 6-cm with a water velocity in the NeST of approximate velocity of 750 cm/day, an α of 45°, and an injection volume of 1 mL at a concentration of 0.5 g/L of NaCl (Figure 3.5). In all cases, a component of vertical flow was indicated by signal detection at the lower vertical detector (HB6), confirming the reproducibility of the result.

A)



HB1 Breakthrough Curve
OPTIMIZED PARAMETER ESTIMATES
cm/hr
VELOCITY(cm/d) 896.833 37.36804
DISPERSIVITY (cm) 0.817439
PULSE WIDTH (cm) 0.001786
RF 1
Co (mV) 2.882335
Electrical Conductivity (mV)
Elapsed Time (Hours)
Calculated
Observed
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
-0.0002
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35

B)



HB2 Breakthrough Curve
OPTIMIZED PARAMETER ESTIMATES
cm/hr
VELOCITY(cm/d) 1209.192 50.38302
DISPERSIVITY (cm) 0.70532
PULSE WIDTH (cm) 0.017766
RF 1
Co (mV) 0.668291
Electrical Conductivity (mV)
Elapsed Time (Hours)
Calculated
Observed
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
-0.0005
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35

C)

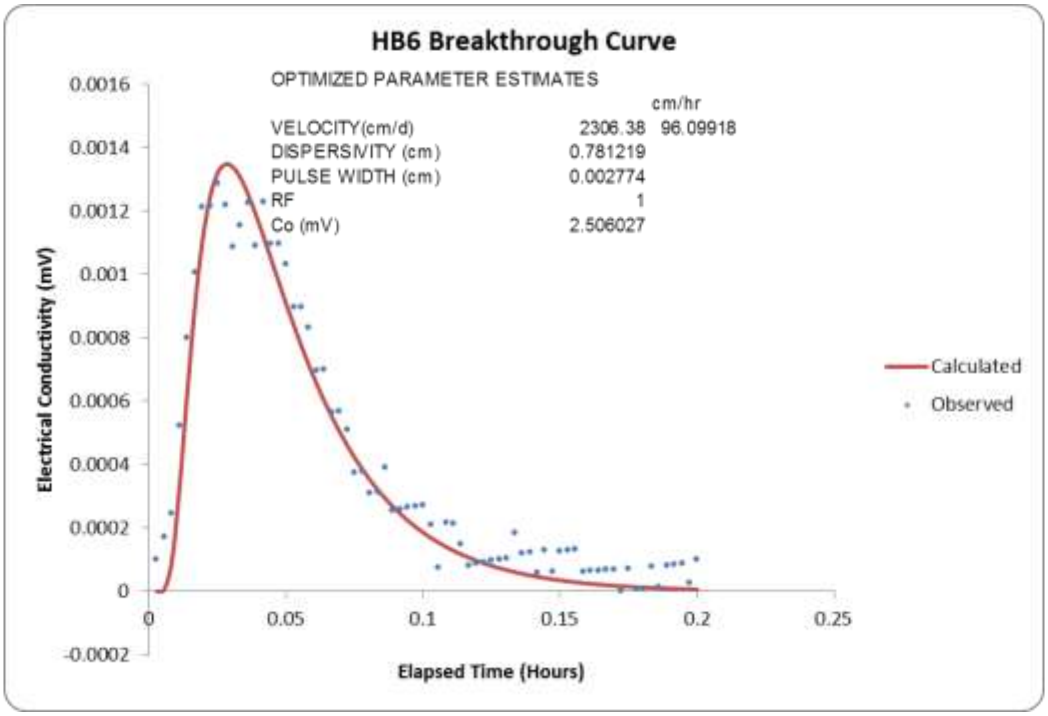


Figure 3.6: A 6-cm PVP experiment in gravel with tank velocity of approximately 750 cm/day, α_K of 45°, injection concentration of 0.5 g/L and injection volume of 1 mL. Results for 06262013_6cm_1317_gravel_45_0.5gL_1_b. HB1 (A), HB2 (B), and HB6 (C).

Accuracy of velocity magnitude and flow angle estimation in gravel: Thirteen experiments were conducted in quadruplicate at α of 45° and varying v_d, using the 6 cm PVP (Table 3.2A and 3.2B). In general, the velocity magnitudes were in good agreement with expectations, but estimated flow angles were more problematic. The v_{meas} values for the 6-cm PVP were found to be within ±5% to ±11% of v_d (Figure 3.8A), whereas the α_{meas} values were within ±36° to ±50° of α (Figure 3.8B). This might be explained in terms of the grain size of the gravel and its effect on the tracer injection volume distribution after injection. The large pores and grains in gravel media are more likely to cause injection volume deformation, compared to injection in sand, potentially establishing a tracer center of mass at t = 0 that does not correspond with the center of the injection port (Figure 3.7).

A) B)

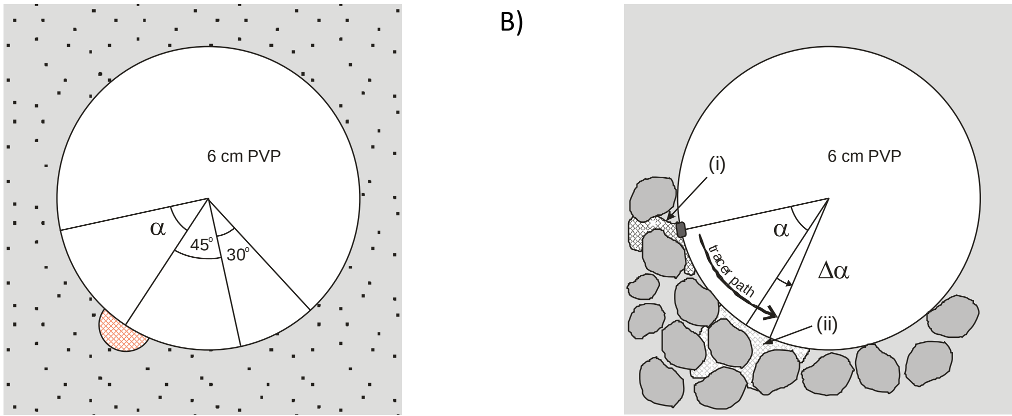


Figure 3.7: Conceptual diagrams explaining possible effects of gravel on flow direction measurements. In sand, (A) tracer is injected to create a relatively ideal volume shape on the probe surface because many pores are sampled during the injection. In gravel (B), fewer pores are sampled, so deformation of the tracer volume is more likely. Deformation of the tracer volume can permit more mass to move off the probe surface at the injection port (i) and to effectively change the tracer center of mass at time = 0, biasing the measured α angle (by $\Delta\alpha$ above, (ii)). The bias could occur with $\Delta\alpha$ in either direction (overestimating α or underestimating α), depending on the grain packing at the injection port.

Table 3.2A: Summary of gravel experimental results for velocity using the 6 cm PVP at 45° to the ambient flow direction.

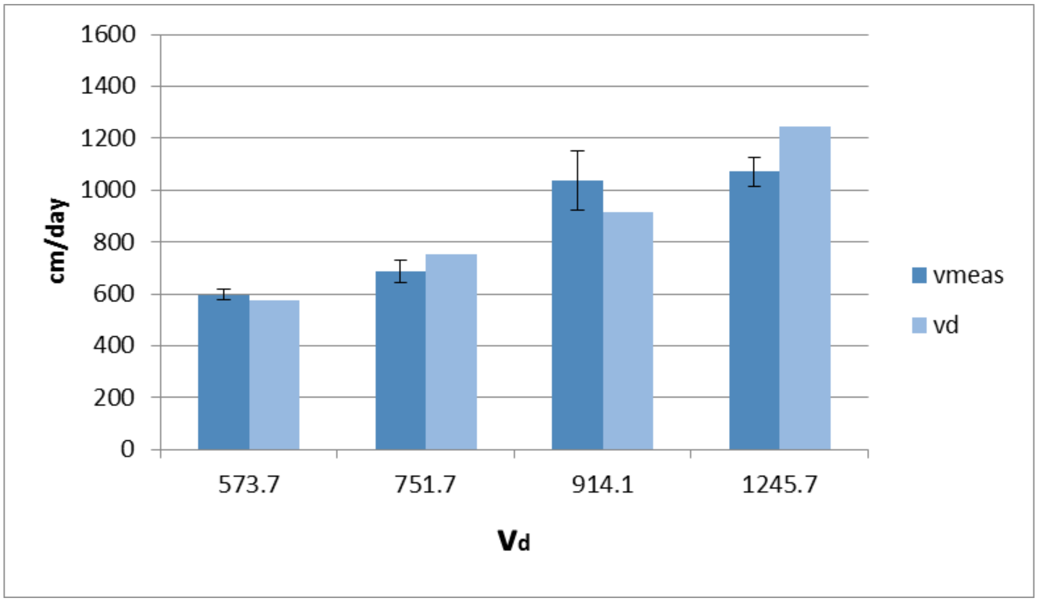
Experiment No.	v_{meas}	Average v_{meas}	v_d	Std Dev Ave v_{meas}	Precision ± Std Dev as % from v_d
No. 1	655.8	694.8	751.7	47.1	6.3
No. 2	771				
No. 3	655.3				
No. 4	696.9				
No. 5	980.7	1071.9	1245.7	65.1	5.2
No. 6	1106.3				
No. 7	1128.6				
No. 8	1163.6	1037.5	914.1	101.6	11.1
No. 9	1034.2				
No. 10	914.8				
No. 11	603.9	597.2	573.7	19.7	3.4
No. 12	617.2				
No. 13	570.4				

Table 3.2B: Summary of gravel experimental results for α using the 6 cm PVP at 45^o to the ambient flow direction.

Experiment No.	α_{meas}	**Average** α_{meas}	**Accuracy of** α **±°**	**Precision of** α **± Std Dev in °**
No. 1	91.9	94.9	49.9	4.2
No. 2	102.1			
No. 3	92.8			
No. 4	92.8			
No. 5	82.3	89.2	44.2	4.9
No. 6	93.2			
No. 7	92.2			
No. 8	1.4	3.5	41.5	2.6
No. 9	2.0			
No. 10	7.2			
No. 11	9.6	9.4	35.6	3.5
No. 12	5.1			
No. 13	13.6			

*The v_{meas} (Table 2A) and α_{meas} (Table 2B) are shown for each individual experiment. The v_d for each suite is also shown. The $v_{meas\ ave}$ and $\alpha_{meas\ ave}$ are also summarized for each suite of experiments. The standard deviation for each experimental suite is also calculated for v_{meas} and α_{meas}.

A)



B)

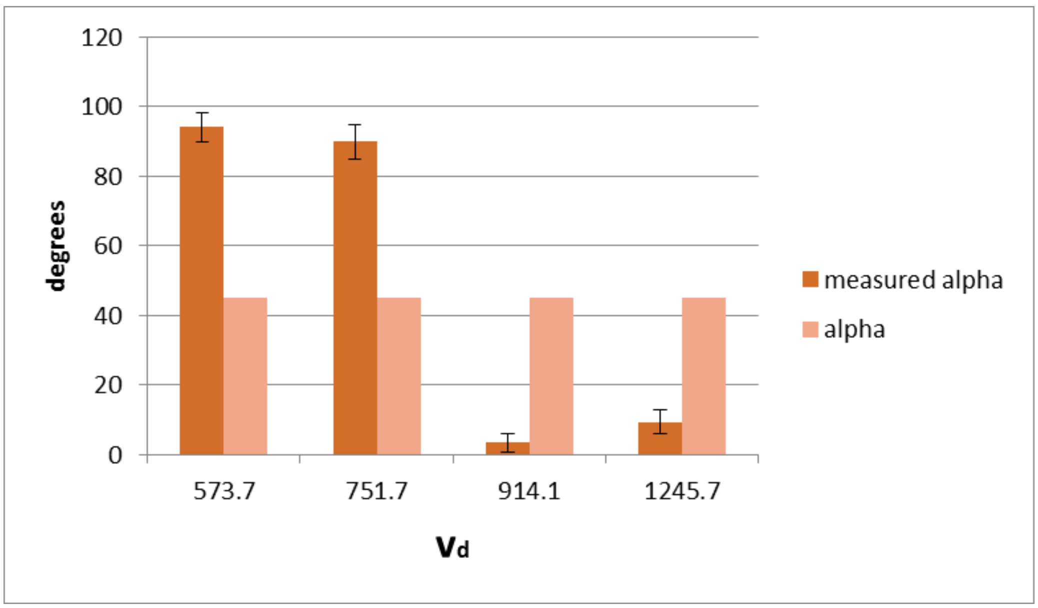
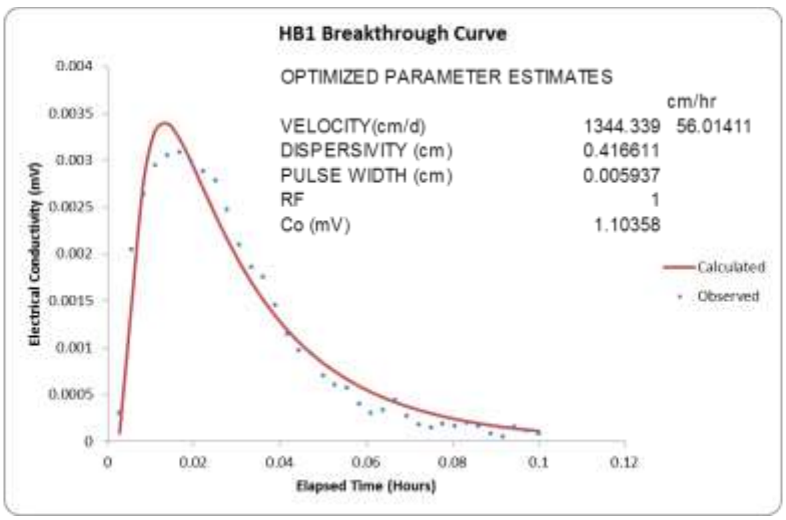


Figure 3.8: (A) Summary of v_{meas} at varying velocities and (B) summary of α_{meas} at varying velocities. Error bars represent one standard deviation.

3.4.2 2-cm PVP

Two suites of experiments consisting of three tests each were conducted in quadruplicate with α set to 45° and v_d at either 1,400 cm/day or 450 cm/day. Breakthrough curves obtained from the 2-cm PVP were less ideal than those obtained with the 6-cm PVP (Figure 3.9A and 3.9B); the calculated breakthrough curves do not match the observed data as well as with the 6-cm probes (Figure 3.9B). Signals received on HB1 and HB2 were again quite weak, possibly for the same reasons as before. Moreover, the signal peak was only defined by 5 points due to the short distance between the injection port and the first detector (HB2). This number of points is adequate for velocity estimation, but represents a near minimum case. Also, post-test audits of the experiment identified gaps in the record of tank discharge measurements, raising the possibility that pumping rate variations were missed. Confidence in this dataset, therefore, may be less than that in other tests with larger PVPs.

A)



B)

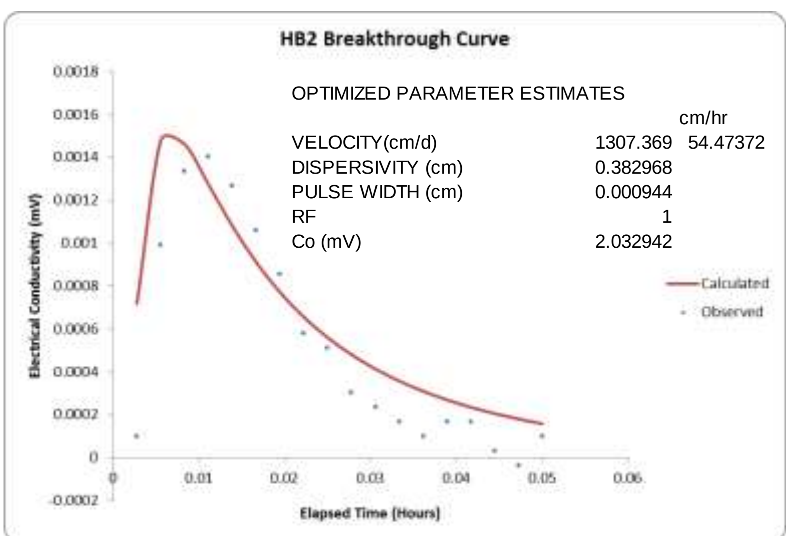


Figure 3.9: Breakthrough curves on HB 1 (A) and HB 2 (B) for 2-cm PVP in gravel. (07082013_2cm_1523_gravel_45_0.5gL-0.1)

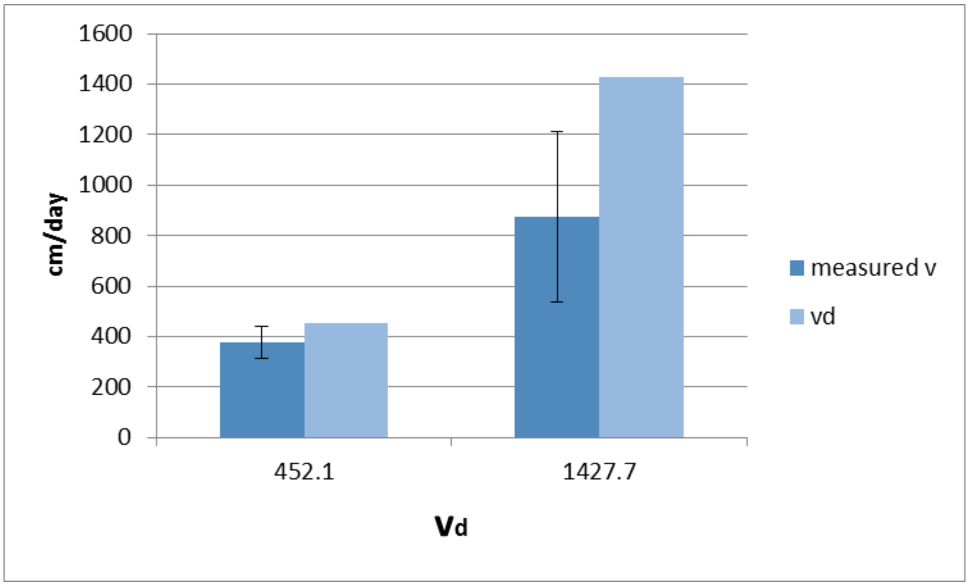
Table 3.4A: Summary of gravel experimental results for velocity using the 2-cm PVP at 45° to the ambient flow direction

Experiment No.	v_{meas}	Average v_{meas}	v_d	Accuracy % from v_d	Std Dev Ave v_d
No. 1	740.5	877.1	1427.7	38.5	135.0
No. 2	1060.9				
No. 3	829.8				
No. 4	360.7	376.5	452.1	16.7	56.7
No. 5	316.4				
No. 6	452.5				

Table 3.4B: Summary of gravel experimental results for α using the 6-cm PVP at 45° to the ambient flow direction

Experiment No.	α_{meas}	Average α_{meas}	Accuracy of α ±°	Precision of α ± Std Dev in °
No. 1	40.3	31.4	13.6	6.5
No. 2	25.1			
No. 3	28.8			
No. 4	77.7	76.6	31.6	14.5
No. 5	58.4			
No. 6	93.8			

A)



B)

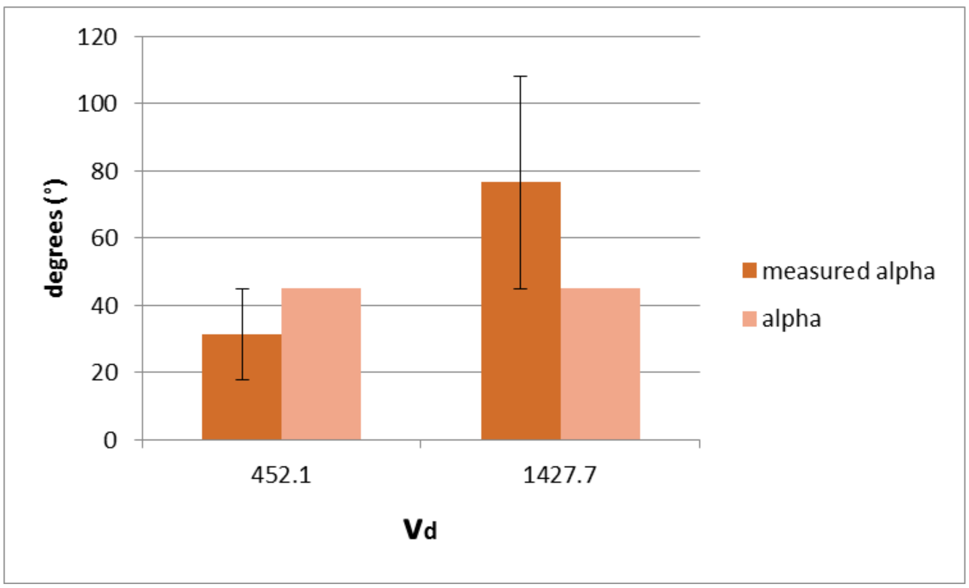


Figure 3.10: (A) Summary of v_{meas} *at varying velocities and (B) summary of* α_{meas} *at varying velocities. Error bars represent one standard deviation.*

Despite the expectations that the 2-cm probes might return highly biased results, the v_{meas} values were found to be within ±17% to ±39% of v_d, and the α_{meas} values were within ±14° to ±32° of α. These results represent a smaller than expected performance decline compared to the 6-cm probe. As was the case with the 6-cm probes, the α_{meas} values of individual tests deviated considerably from expected values of α, but here the expected values tended to lie within the range of experimentally measured values (Figure 3.10B). Thus, there appears to have been a greater loss of precision in the 2-cm PVP tests, rather than accuracy, compared to the 6-cm PVP tests. This might be improved with a more highly controlled injection procedure. Slower, more evenly administered injections might improve both reproducibility and the proportion of tracer mass that remains in contact with the probe surface.

3.5 Sensitivity Evaluation

Due to the differences in the estimated and measured velocities in the 2 cm PVP tests, a sensitivity analysis was done to further evaluate the reliability of the estimated and the measured velocities. The sensitivity analysis was completed for both the 6 cm PVP and the 2 cm PVP. As discussed in Devlin (in review), PVPs that are designed with detector sets at γ_1 = 45° and γ_2 = 75° have a range over which α can be measured most reliably. The maximum theoretical range for any measurement of α is from 0° to 105°. Above this angle, the tracer will not reach the second detector set. The tracer's nearness to this imitating angle can be tracked through the v_{app1}/v_{app2} ratio. In the case of PVPs where γ_1 = 45° and γ_2 = 75°, the acceptable range of that ratio is 0.66 to 1.3 (Devlin, pers. comm.). The results for the 6-cm PVP analysis generally indicate that ratios fall within the acceptable range (Table 3.5), except for one experiment (6/26/2013 at 13:17). The breakthrough curves were refit with VelProbe to determine if recalculated apparent velocities would result in an acceptable ratio (Table 3.6). The refit resulted in an acceptable ratio of 1.31.

Table 3.5: Summary of apparent velocity ratios for 6 cm PVP experiments in gravel

6cm Gravel Experiments					
date	experiment	v_{app1}	v_{app2}	ratio	v_{meas} (cm/d)
6/26/2013	12:57	1144.663	917.0117	1.25	655.8
6/26/2013	13:17	1209.192	896.833	1.35	771
6/26/2013	13:48	1135.543	904.6733	1.26	655.3
6/26/2013	14:11	1207.046	961.2422	1.26	696.9

6cm Gravel Experiments					
6/26/2013	14:56	1827.144	1550.404	1.18	980.7
6/26/2013	15:19	1910.543	1518.1	1.26	1106.3
6/26/2013	15:34	1966.166	1572.771	1.25	1128.6
7/5/2013	14:45	970.7249	1393.058	0.70	1163.6
7/5/2013	15:00	881.2398	1252.948	0.70	1034.2
7/5/2013	15:21	921.9151	1220.352	0.76	914.8
7/5/2013	16:01	650	837.2549	0.78	603.9
7/5/2013	16:26	584.4975	794.1638	0.74	617.2
7/5/2013	16:56	676.4643	837.3748	0.81	570.4

Table 3.6: Results of apparent velocity ratio for re-evaluated 6-cm PVP experiment in gravel

6/26/2013	13:17	1209.192	924.4628	1.31	738.3

The ratio was calculated for each experiment with the 2-cm PVP and it was again found that the measured apparent velocities were within the acceptable range, lending confidence to the 2-cm PVP measurements (Table 3.7).

Table 3.7: Summary of apparent velocity ratios for 2-cm PVP experiments in gravel

2cm Gravel Experiments					
date	experiment time	v_{app1}	v_{app2}	ratio	v_{meas} (cm/d)
7/8/2013	15:23	1307.369	1344.339	0.97	740.5
7/8/2013	15:37	1587.88	1770.6	0.90	1060.9
7/8/2013	15:45	1305.666	1424.306	0.92	829.8
7/8/2013	16:27	678.936	589.571	1.15	360.7
7/8/2013	16:44	608.5475	576.9651	1.05	316.4
7/8/2013	17:10	762.8057	604.2552	1.26	452.5

These findings generally indicate that the measured velocities for the 6-cm and the 2-cm PVPs were within the α range for reliability. They did not always agree with the expected velocity values, possibly because of injection volume deformation, as previously discussed, or because the expected values are themselves subject to some uncertainty (e.g. pump-head-tubing wear, consistency of the pump speed, consistency of the water level in the tank). The NeST scale expected velocities are tank-wide averages, not necessarily the velocities at the probe location. The velocity magnitudes measured by the 6-cm and 2-cm probes are therefore considered good in these tests. On the other hand, the velocity directions may appear to be subject to increased error compared to measurements in sand.

3.6 Conclusions

PVPs can be used to obtain reasonable estimates of groundwater speed in gravel media. However, with increasing coarseness of the aggregate particles, estimated directions of flow become less useful, reflecting conditions next to the probe that are quite different from those in the aquifer in general. In this work, involving a well sorted gravel with a d_{10} of about 5 mm, the velocity magnitude was measured with 6 cm diameter probes within 11% of expected values, and flow directions within about 45^{o} of expected values. In a field program with numerous probes available for making measurements in a poorly sorted sandy gravel, Schillig *et al*. (in review) found that average values agreed well with expectations, so the conclusions of this study may be limited to well sorted, coarse gravel.

The results of this work, particularly where velocity directions are concerned, support the hypothesis that PVP performance depends on the relationship between the probe dimensions and the aggregate size. Further work is needed to explore this dependency in greater detail, but these preliminary findings suggest that as the grain diameters approach the distances between injection ports and detectors, the continuum assumption loses validity and flow on the probe surface departs from the ideal case described by the PVP equations. More specifically, causes of the performance loss may be related to several issues. 1) In gravel medium there is a greater chance that the initial tracer volume becomes established with a center of mass removed from the injection port. This immediately biases the estimated values of apparent velocity on the probe surface and hence the final velocity estimate. 2) The relatively large size of each gravel grain redirects flow in a fashion that departs noticeably from the case of a sandy medium. 3) The large pores in well-sorted gravel provide pathways that can carry tracer mass off the probe surface, resulting in weak signals at the detectors due to either dilution in the large pores, or simply by advection of a large fraction of tracer mass away from the probe during the injection.

Smaller diameter PVPs are subject to greater measurements errors than larger diameter PVPs in gravel media. In this work, the 2-cm diameter PVPs returned velocity magnitudes within ±39% of expected values, though uncertainties in the expected values were not quantified in these tests. Flow directions were estimated within 40^{o} of expected values, similar to the results obtained from the 6-cm PVPs. Despite the indications of performance losses with the smaller probes, the speed estimates are still were fairly good agreement with expected values and may be useful as preliminary or supplementary estimates in some cases. Thus, PVPs can be generally useful instruments for the measurement of groundwater velocities in gravel media, although at least 6-cm diameter probes are recommended over smaller sizes.

3.7 References

Berg, S. J. and R. W. Gillham. 2010. Studies of water velocity in the capillary fringe: the point velocity probe. *Ground Water* 48, no. 1: 59-67.

Bowen, I. R., Devlin, J.F., and P.C. Schillig. 2012. Design and Testing of a Convenient Benchtop Sandbox for Controlled Flow Experiments. *Ground Water Monitoring & Remediation* 32, no. 4: 87-91.

Chapuis, R.P. 2004. Predicting the saturated hydraulic conductivity of sand and gravel using effective diameter and void ratio. *Canadian Geotechnical Journal*, v. 41, 787–795.

Devlin, J.F., Tsoflias, G., McGlashan, M., and P. Schillig. 2009. An Inexpensive Multilevel Array of Sensors for Direct Ground Water Velocity Measurement. *Ground Water Monitoring & Remediation* 29, no. 2: 73-77.

Devlin, J.F., Schillig, P.C., Bowen, I., Critchley, C.E., Rudolph, D.L., Thomson, N.R., Tsoflias, G.P., and J.A. Roberts. 2012. Applications and implications of direct groundwater velocity measurement at the centimetre scale. *Journal of Contaminant Hydrology* 127, no. 1-4: 3-14.

Devlin, J.F. 2014. Hydrosieve v. 1.1.

Devlin, J.F. In review. Sensitivity Analysis of Groundwater Velocity Measurements Made With Point Velocity Probes (PVPs).

Gibson, B. (in preparation). Title Pending. M.S. Thesis, Department of Geology, University of Kansas, Lawrence, KS.

Labaky, W., Devlin, J.F., and R.W. Gillham. 2007. Probe for Measuring Groundwater Velocity at the Centimeter Scale. *Environmental Science & Technology* 41, no. 24: 8453-8458.

Schillig, P.C., Devlin, J.F., Roberts, J.A., Tsoflias, G.P, and M.A. McGlashan. 2011. Transient Heterogeneity in an Aquifer Undergoing Bioremediation of Hydrocarbons. *Ground Water* 49, no. 2: 184-196.

Schillig, P.C., Devlin, J.F., McElwee, C.D., Walter, K., and B. Gibson. (In press). Assessment of Density Induced Tracer Movement in Groundwater Velocity Measurements with Point Velocity Probes (PVPs). *Ground Water Monitoring and Remediation*.

Walter, K. (in Preparation). Title Pending. M.S. Thesis, Department of Geology, University of Kansas, Lawrence, KS.

4.0 Conclusions and Recommendations

4.1 Conclusions

PVPs have been shown in prior studies to be reliable in measuring groundwater direction and magnitude, both in laboratory and field settings. That work was extended here by examining the dependency of PVP size on the accuracy of velocity measurements, and by examining the effect of grain size on the accuracy and precision of the measurements.

Results of experimentation with four sizes of PVPs in sandy media generally indicate that velocity measured is only slightly affected by PVP probe size for probe diameters between 4-cm and 6-cm. In these cases, velocities could be routinely estimated with 25% of the expected values and directions within 18^{o} of the expected angle. One important trend noted during the sand experiments was that the measurement accuracy of direction appeared to decrease with decreasing PVP size. The 2-cm PVPs could be relied upon to return velocities within 29% and 46^{o} of the expected values. A 6-cm PVP in diameter or greater is recommended for the most accurate determination of groundwater flow direction.

Laboratory tests with the largest PVP (11-cm diameter) in sand were limited by relative size of the PVP with respect to the tank size. In some tests, the large probes caused unintended flow patterns, particularly in the vertical downward direction, which compromised the horizontal estimates of velocity. In situations where vertical flow was prevented, the 11-cm PVP, the velocity and direction measurements were generally more accurate than measurements made with the 6-cm PVP. Use of larger PVPs, therefore, may be optimal in the field if determining direction and velocity with high confidence is desired.

Obtaining meaningful results with the 6-cm PVP in the gravel was initially challenged by the effects of vertical flow due to the density differences between the tracer and the ambient tank water. This problem was less pronounced in tests with higher horizontal velocities, as predicted by theory. Nevertheless, in all cases signals were weaker and more difficult to fit with the advection dispersion equation in the gravel media than in the sand media. This is thought to be due to a loss of validity of the continuum assumption at the scale of the PVP test in the well-sorted, coarser grained media. Prior field tests suggest that in less well-sorted gravel deposits better velocity estimates are possible to obtain, suggesting that the presence of large open pores is the primary source of the performance issues. The testing indicated that where the scale of the grain diameters approached the distances between the injection ports and the detectors, flow behaved in a fashion that departed from the ideal described by the PVP equations. Although there was a loss in quality in measurements of velocity and direction with the PVPs in gravel, the results remained relatively good, compared to what might be obtainable from conventional methods.

4.2 Recommendations

Customization of PVP construction for site-specific conditions is recommended and factors to consider for PVP design may include the grain size of the media of interest, the desire for highly accurate velocity, the desire for highly accurate direction and the ambient aquifer density with respect to tracer concentration. Other things to consider may include the desired investigation depth in which deployment of small PVPs by hand may be easy in shallow unconsolidated river sediments, but greater deployment depth may require larger PVP sizes to fit larger borehole diameters and construction with more robust materials.

Further testing of the smallest PVPs in the field is recommended to determine their reliability in measuring groundwater velocity. Caution must be exercised, however, in the case where direction of groundwater is important to determine. Testing of the smallest PVPs could be done in situations where understanding movement between surface water and groundwater in shallow sediments is desired. The use of PVPs smaller than 6-cm in diameter is not recommended for gravel or in any media where high confidence in groundwater flow direction is necessary to understand. Further investigation with PVPs of a larger diameter, such as the 11-cm PVP (modeled to fit on a 4 inch diameter PVC well pipe sand) is recommended to evaluate its efficacy in gravel. If further testing of the 11-cm PVP is continued in the laboratory, a larger scaled aquifer simulated system is required to avoid vertical flow conditions due to blockage by the PVP in a small cross-sectional area. A higher degree of control for laboratory experiments with gravel is also recommended, including accurate measurement of porosity and discharge used to determine the estimated tank flow velocity.

APPENDIX A

Sketchup PVP Models

6cm PVP

Figure 1: Views of 6 cm PVP

A)

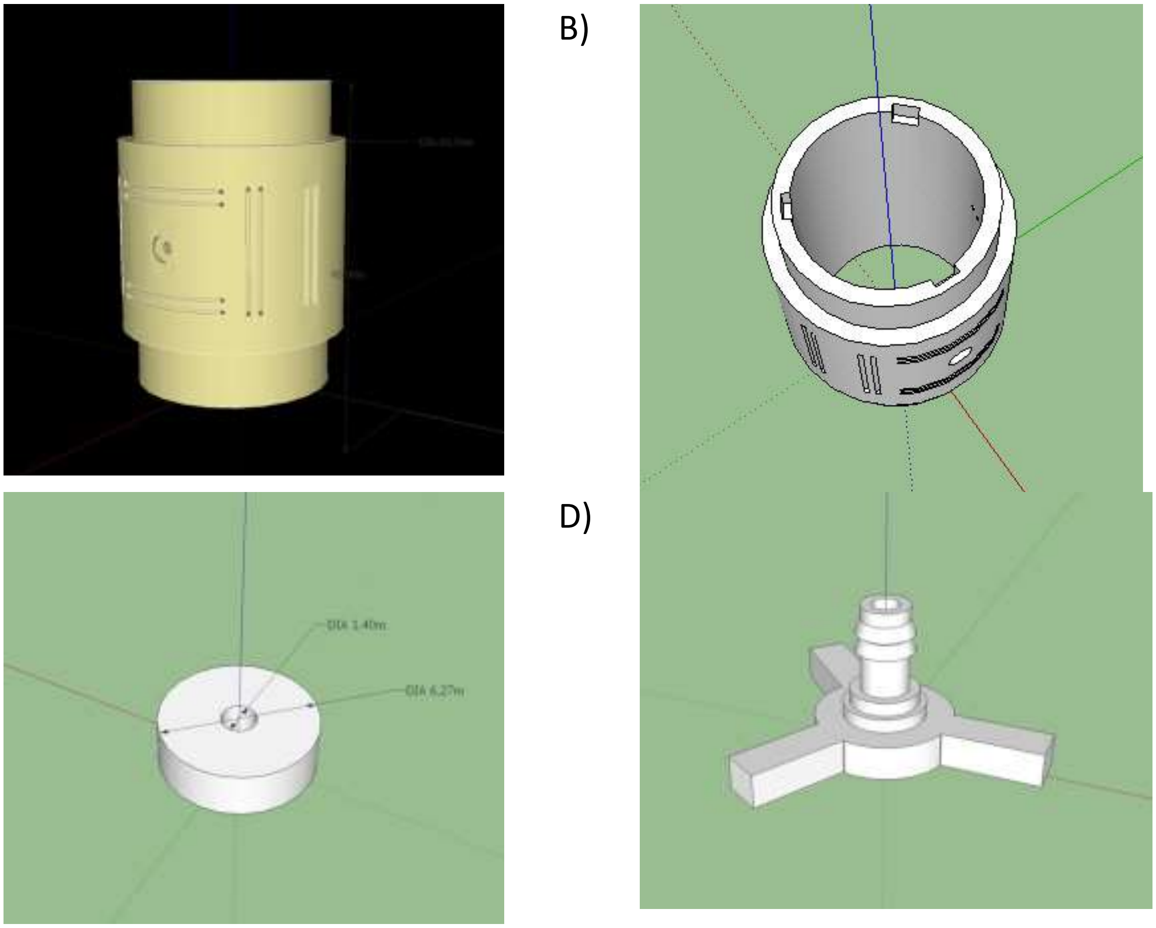


Figure 1: (A) 3-D view of 6 cm PVP (B) 3-D view of 6 cm PVP from top (C) 3-D view of 6 cm PVP injection port plug (D) Top of 6 cm PVP. All views were generated in Sketchup.

4cm PVP

Figure 2: Views of 4 cm PVP

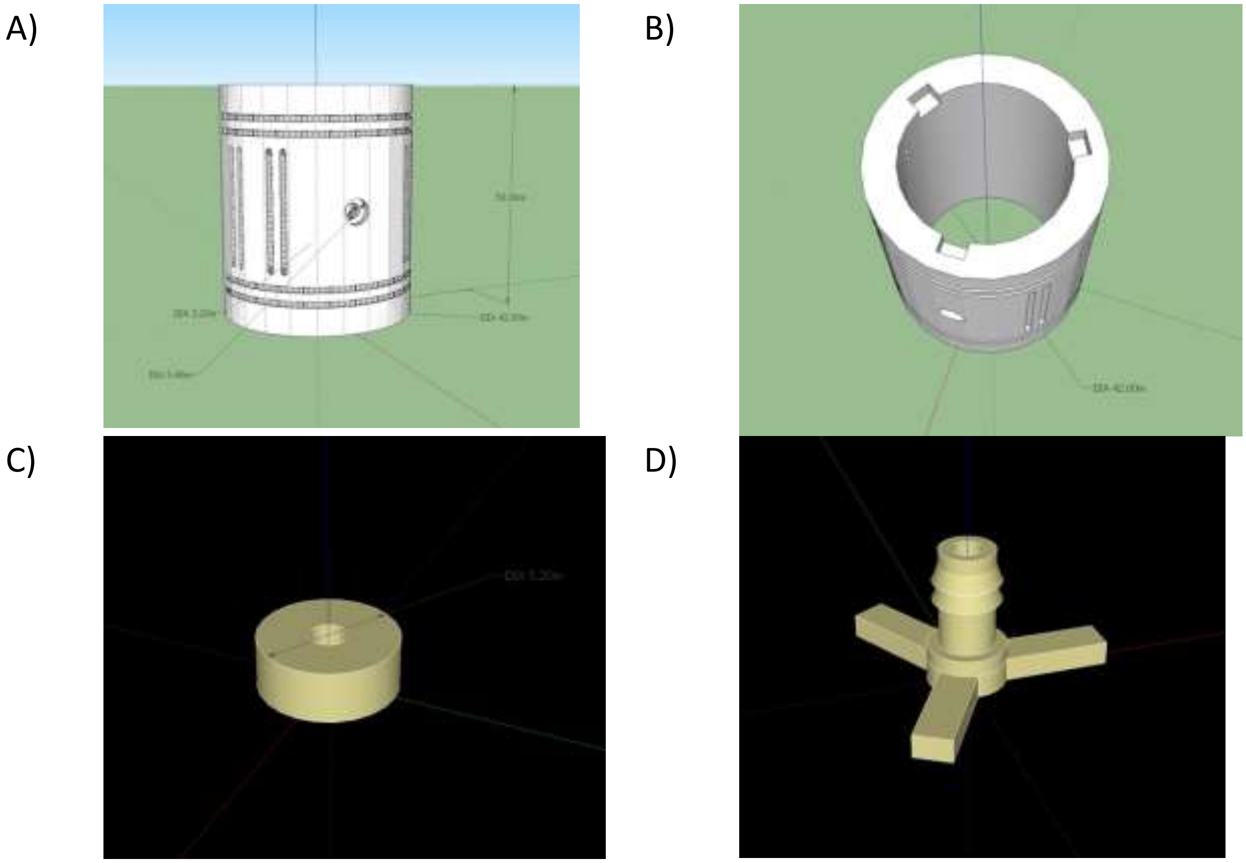
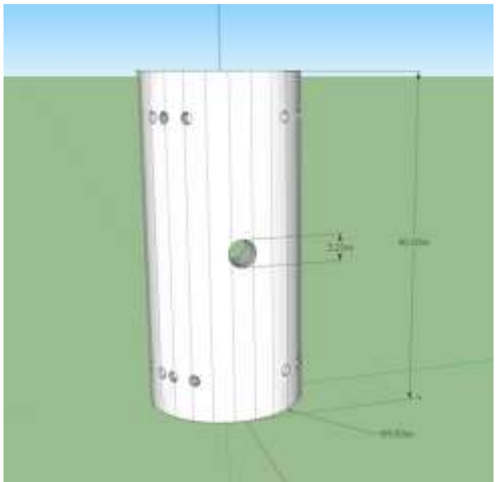


Figure 2: (A) 3-D view of 4 cm PVP (B) 3-D view of 4 cm PVP from top (C) 3-D view of 4 cm PVP injection port plug (D) Top of 4 cm PVP. All views were generated in Sketchup.

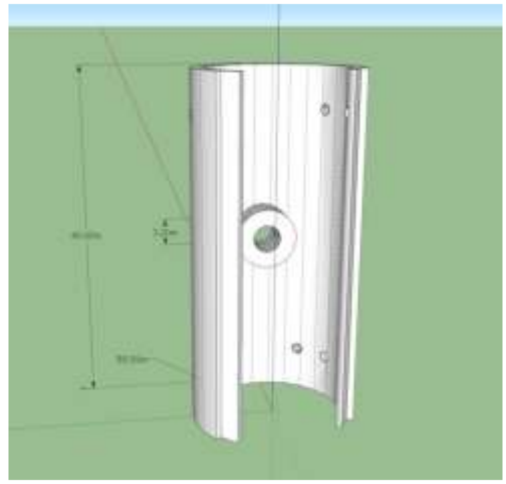
2cm PVP

Figure 3: Views of 2 cm PVP

A)



B)



C)

Figure 3: (A) 3-D view of 2 cm PVP (B) 3-D view of 2 cm PVP from open back (C) 3-D view of 2 cm PVP back plate. All views were generated in Sketchup.

11cm PVP

Figure 4: Views of 11 cm PVP

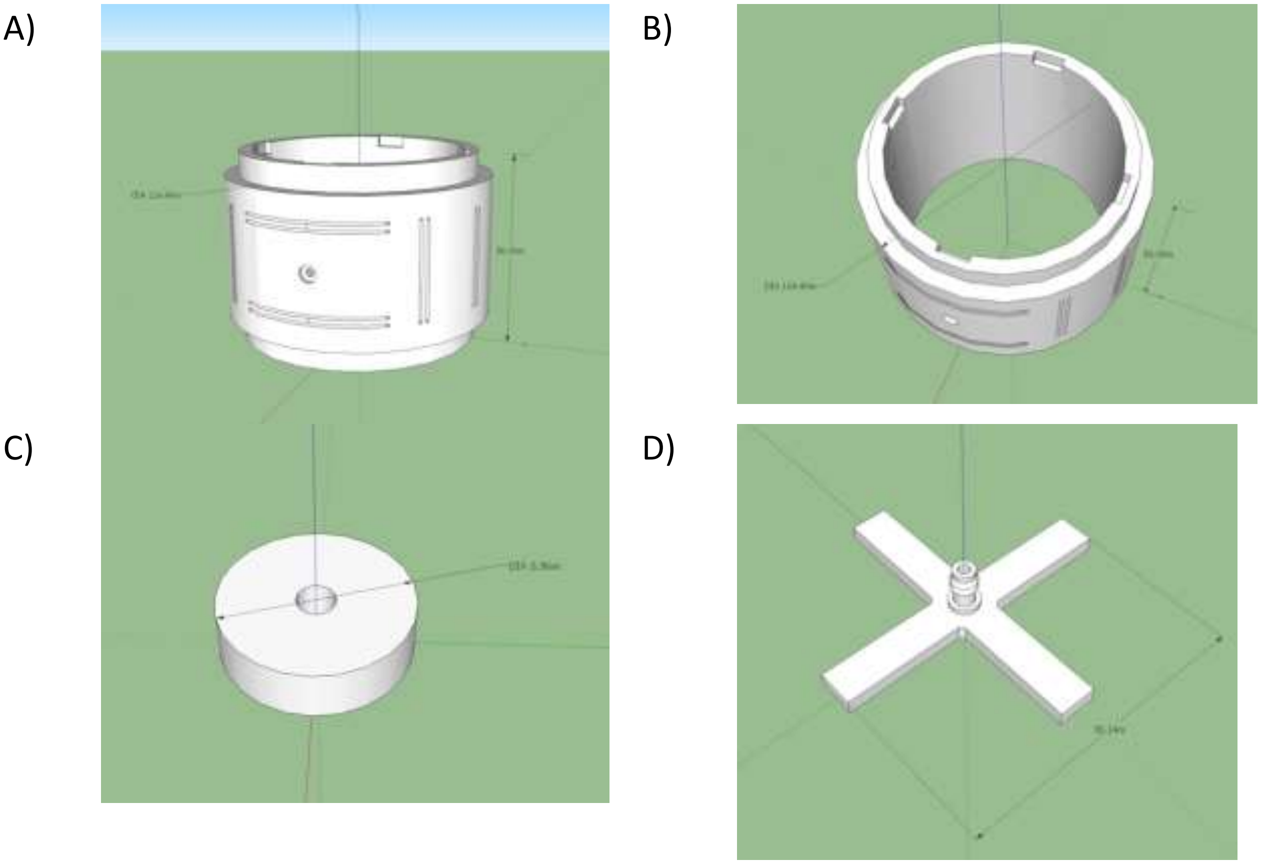


Figure 4: (A) 3-D view of 11 cm PVP (B) 3-D view of 11 cm PVP from top (C) 3-D view of 11 cm PVP injection port plug (D) Top of 11 cm PVP. All views were generated in Sketchup.

APPENDIX B

Experiment Summary Tables

Table 1: Summary of grain size analysis weights for "medium-grained sand" (MS)

Metric	Sieve No.	Dish ID	dish mass	mass MS	mass in dish MS	% in dish MS
1.4mm	14	1	1.8566	1.8571	0.0005	0.0
710µm	25	2	1.8407	3.14	1.2993	4.3
355µm	45	3	1.7947	21.9717	20.177	66.7
250µm	60	4	1.803	9.5465	7.7435	25.6
90µm	170	5	1.8262	2.8614	1.0352	3.4
6.3µm	230	6	1.8786	1.8829	0.0043	0.0
base pan	clay/silt	7	1.9223	1.9333	0.011	0.0

**all masses are in grams*

Table 2: Summary of grain size analysis weights for "fine-grained sand" (FS)

Metric	Sieve No.	Dish ID	dish mass	mass FS	mass in dish FS	% in dish FS
1.4mm	14	1	1.8566	1.857	0.0004	0.0
710µm	25	2	1.8407	1.8428	0.0021	0.0
355µm	45	3	1.7947	3.3875	1.5928	5.4
250µm	60	4	1.803	11.4589	9.6559	32.5
90µm	170	5	1.8262	20.0434	18.2172	61.3
6.3µm	230	6	1.8786	2.0673	0.1887	0.6
base pan	clay/silt	7	1.9223	1.99	0.0677	0.2

**all masses are in grams*

Table 3: Summary of porosity measurements for "fine sand" and "medium sand"

sample	dry beaker (g)	beaker with dry sample (g)	beaker with saturated sample (g)	media mass (g)	sample volume (cm^3)	ρ_b (g/cm^3)	void water (g)	φ	average φ ± 1 st. dev.
FS1	106.81	448.92	521.13	342.11	200	1.71	72.21	0.361	0.362 ± 0.001
FS2	108.89	449.47	522.13	340.58	200	1.70	72.66	0.363	
FS3	108.85	444.79	516.94	335.94	200	1.68	72.15	0.361	
MS1	109.18	441.79	514.38	332.61	200	1.66	72.59	0.363	0.367 ± 0.006
MS2	110.03	443.50	518.27	333.47	200	1.67	74.77	0.374	
MS3	107.60	449.67	522.40	342.07	200	1.71	72.73	0.364	

FS – fine sand, MS – medium sand

Table 4: Average Linear Velocity Results for 6cm PVP Experiments in Medium-Grained Sand

α ***angle***	***15°***	***30°***	***45°***	***45°***	***75°***
No. 1	237.0	141.7	247.6	287.4	299.3
No. 2	236.0	194.3	251.6	283.9	307.6
No. 3	237.9	208.9	254.5	285.1	315.9
No. 4			255.2		
Average v_{meas}	237.0	181.7	252.2	285.5	307.6
v_d	209.6	206.8	209.6	216.6	216.6
Std. Dev.	0.8	28.9	3.0	1.4	6.8
Accuracy (% from v_d)	13	-12	21	32	42
Precision (± Std. Dev. as % v_d)	0.37	13.96	1.43	0.67	3.12

Table 5: Average Calculated α Results for 6cm PVP Experiments in Medium-Grained Sand.

α ***angle***	***15°***	***30°***	***45°***	***45°***	***75°***
No. 1	17.8	22.6	42.9	47.3	92.0
No. 2	18.9	26.7	44.2	44.7	92.4
No. 3	18.5	26.4	38.7	45.1	93.3
No. 4			48.9		
Average αcalc	18.4	25.2	43.7	45.7	92.6
Accuracy (± °)	3.4	4.8	1.3	0.7	17.6
Precision (± Std. Dev. in °)	0.5	1.9	2.3	1.1	0.5

Table 6: Average Linear Velocity Results for 4 cm PVP Experiments in Medium-Grained Sand

α angle	***15°***	***30°***	***45°***	***75°***	***75°***
No. 1	234.9	235.0	241.6	229.8	452.7
No. 2	236.9	233.5	240.4	229.8	460.8
No. 3	237.0	233.5	236.9	230.8	455.8
Average v_{meas}	236.2	234.0	239.6	230.2	456.4
v_d	209.0	184.4	207.9	184.4	395.2
Std. Dev.	1.0	0.7	2.0	0.5	3.3
Accuracy (% from v_d)	13	27	15	25	15
Precision (± Std. Dev. as % v_d)	0.47	0.38	0.97	0.26	0.85

Table 7: Average Calculated α Results for 4 cm PVP Experiments in Medium-Grained Sand

α angle	***15°***	***30°***	***45°***	***75°***	***75°***
No. 1	9.0	20.4	28.7	64.5	58.7
No. 2	8.4	20.1	27.5	63.5	59.5
No. 3	8.2	19.4	24.8	64.2	59.2
Average α_{meas}	8.5	20.0	27.0	64.1	59.1
Accuracy (± °)	6.8	10.6	20.2	11.5	16.3
Precision (± Std. Dev. in °)	0.4	0.4	1.7	0.4	0.3

Table 8: Average Linear Velocity Results for 2 cm PVP Experiments in Medium-Grained Sand

Average Linear Velocity for 2cm PVP (cm/d)						
α angle	***15°***	***15°***	***30°***	***45°***	***45°***	***75°***
No. 1	213.1	201.1	194.9	177.5	242.1	220.7
No. 2	215.0	199.1	205.3	178.7	219.7	220.3
No. 3	218.7	198.2	204.3	177.3	222.2	210.5
No. 4				175.9		
Average v_{meas}	215.6	199.5	201.5	177.3	228.0	217.2
v_d	192.3	184.2	192.3	182.9	184.2	189.9
Std. Dev.	2.3	1.2	4.7	1.0	10.0	4.7
Accuracy (% from v_d)	12	8	5	-3	24	5
Precision (± Std. Dev. as % v_d)	1.20	0.65	2.43	0.54	5.44	2.49

Table 9: Average Calculated *α* Results for 2 cm PVP Experiments in Medium-Grained Sand

Estimated α for 2cm PVP (°)						
α angle	***15°***	***15°***	***30°***	***45°***	***45°***	***75°***
No. 1	0.5	6.4	1.4	21.8	3.1	31.7
No. 2	0.1	4.0	5.4	18.7	8.7	31.8
No. 3	0.8	0.6	4.5	10.4	7.0	29.5
No. 4				15.6		
Average α_{meas}	0.5	3.7	3.8	16.6	6.3	31.0
Accuracy (± °)	14.9	14.4	28.6	34.6	41.9	45.5
Precision (± Std. Dev. in °)	0.3	2.4	1.7	4.2	2.3	1.1

Table 10: Average Linear Velocity Results for 11 cm PVP Experiments in Medium-Grained Sand

α angle	***15°***	***30°***	***45°***	***45°***	***75°***
No. 1	NM	314.4	160.8	281.6	359.2
No. 2	NM	312.4	160.0	282.3	352.5
No. 3	NM	311.8	160.5	319.2	353.5
Average v_{meas}	NA	312.9	160.4	294.4	355.1
v_d	NA	232.4	177.8	232.4	232.4
Std. Dev.	NA	1.1	0.4	17.5	2.9
Accuracy (% from v_d)	NA	35	-10	27	53
Precision (± Std. Dev. as % v_d)	NA	0.48	0.21	7.55	1.27

Table 11: Average Calculated *α* Results for 11 cm PVP Experiments in Medium-Grained Sand

α angle	***15°***	***30°***	***45°***	***45°***	***75°***
No. 1	NM	29.4	47.6	42.5	83.3
No. 2	NM	28.3	47.3	44.0	82.4
No. 3	NM	28.3	47.9	53.1	82.6
Average α_{meas}	NA	28.7	47.6	46.6	82.8
Accuracy (+/- °)	NA	1.7	2.9	8.1	8.3
Precision (± Std. Dev. in °)	NA	0.5	0.2	4.7	0.4

Table 12: Average Linear Velocity Results for 6 cm PVP Experiments in Fine-Grained Sand

α angle	***15°***	***30°***	***45°***	***75°***
No. 1	304.7	351.5	387.9	374.7
No. 2	305.2	350.3	362.0	367.0
No. 3	309.7	362.9	355.8	370.5
No. 4	313.9			
Average v_{meas}	308.4	354.9	368.6	370.6
v_d	295.6	298.8	298.8	298.8
Std. Dev.	3.7	5.7	13.9	3.2
Accuracy (% from v_d)	4	19	23	24
Precision (± Std. Dev. as % v_d)	1.3	1.9	4.6	1.0

Table 13: Average Calculated α Results for 6 cm PVP Experiments in Fine-Grained Sand

α angle	***15°***	***30°***	***45°***	***75°***
No. 1	26.2	37.8	44.8	83.6
No. 2	26.1	37.1	43.0	83.4
No. 3	34.5	39.0	42.4	83.6
No. 4	29.1			
Average α_{meas}	29.0	38.0	43.4	83.1
Accuracy (± °)	14.0	8.0	1.6	8.1
Precision (± Std. Dev. in °)	3.4	0.8	1.0	0.6

Table 14: Average Linear Velocity Results for 4 cm PVP Experiments in Fine-Grained Sand

α angle	***15°***	***30°***	***45°***	***75°***
No. 1	170.7	201.5	309.9	331.3
No. 2	173.4	201.6	323.5	333.6
No. 3	170.1	198.6	325.5	326.9
Average v_{calc}	171.4	200.6	319.6	330.6
v_d	169.4	169.4	304.4	304.4
Std. Dev.	1.4	1.4	6.9	2.8
Accuracy (% from v_d)	1	18	5	9
Precision (± Std. Dev. as % v_d)	0.8	0.8	2.3	0.9

Table 15: Average Calculated α Results for 4 cm PVP Experiments in Fine-Grained Sand

α angle	***15°***	***30°***	***45°***	***75°***
No. 1	4.1	17.3	27.9	66.7
No. 2	4.9	19.9	26.3	68.0
No. 3	5.0	17.0	26.0	66.1
Average α_{meas}	4.7	18.1	26.8	66.9
Accuracy (± °)	10.3	11.9	18.2	8.1
Precision (± Std. Dev. in °)	0.4	1.3	0.8	0.8

Table 16: Average Linear Velocity Results for 2 cm PVP Experiments in Fine-Grained Sand

α angle	***15°***	***30°***	***45°***	***75°***
No. 1	136.3	173.4	214.0	184.0
No. 2	142.7	167.1	193.9	180.6
No. 3	142.4	175.4	189.6	178.0
Average v_{calc}	140.5	172.0	199.1	180.9
v_d	197.0	197.0	197.3	197.3
Std. Dev.	2.9	3.5	10.6	2.5
Accuracy (% from v_d)	-29	-12	1	8
Precision (± Std. Dev. as % v_d)	1.5	1.8	5.4	1.3

Table 17: Average Calculated *α* Results for 2 cm PVP Experiments in Fine-Grained Sand

α angle	***15°***	***30°***	***45°***	***75°***
No. 1	7.7	10.4	16.0	43.7
No. 2	6.2	10.4	13.4	41.8
No. 3	6.3	5.9	13.0	41.3
Average α_{meas}	6.7	8.9	14.1	42.3
Accuracy (± °)	8.3	21.1	30.9	32.7
Precision (± Std. Dev. in °)	0.7	2.2	1.3	1.0

Table 18: Average Linear Velocity Results for the 6 cm PVP in Gravel

Experiment No.	v_{meas}	Average v_{meas}	v_d	Std Dev Ave v_{meas}	Precision ± Std Dev as % from v_d
No. 1	655.8	694.8	751.7	47.1	6.3
No. 2	738.3				
No. 3	655.3				
No. 4	696.9				
No. 5	980.7	1071.9	1245.7	65.1	5.2
No. 6	1106.3				
No. 7	1128.6				
No. 8	1163.6	1037.5	914.1	101.6	11.1
No. 9	1034.2				
No. 10	914.8				
No. 11	603.9	597.2	573.7	19.7	3.4
No. 12	617.2				
No. 13	570.4				

Table 19: Average Calculated α Results for 2 cm PVP Experiments in Gravel

Experiment No.	α_{meas}	Average α_{meas}	Accuracy of α ±°	Precision of α ± Std Dev in °
No. 1	91.9	94.9	49.9	4.2
No. 2	98.4			
No. 3	92.8			
No. 4	92.8			
No. 5	82.3	89.2	44.2	4.9
No. 6	93.2			
No. 7	92.2			
No. 8	1.4	3.5	41.5	2.6
No. 9	2.0			
No. 10	7.2			
No. 11	9.6	9.4	35.6	3.5
No. 12	5.1			
No. 13	13.6			

Table 20: Average Linear Velocity Results for the 2 cm PVP in Gravel

Experiment No.	v_{meas}	Average v_{meas}	v_d	Accuracy % from v_d	Std Dev Ave v_d
No. 1	740.5	877.1	1427.7	38.5	135.0
No. 2	1060.9				
No. 3	829.8				
No. 4	360.7	376.5	452.1	16.7	56.7
No. 5	316.4				
No. 6	452.5				

Table 21: Average Calculated α Results for 2 cm PVP Experiments in Gravel

Experiment No.	α_{meas}	Average α_{meas}	Accuracy of α ±°	Precision of α ± Std Dev in °
No. 1	40.3	31.4	13.6	6.5
No. 2	25.1			
No. 3	28.8			
No. 4	77.7	76.6	31.6	14.5
No. 5	58.4			
No. 6	93.8			

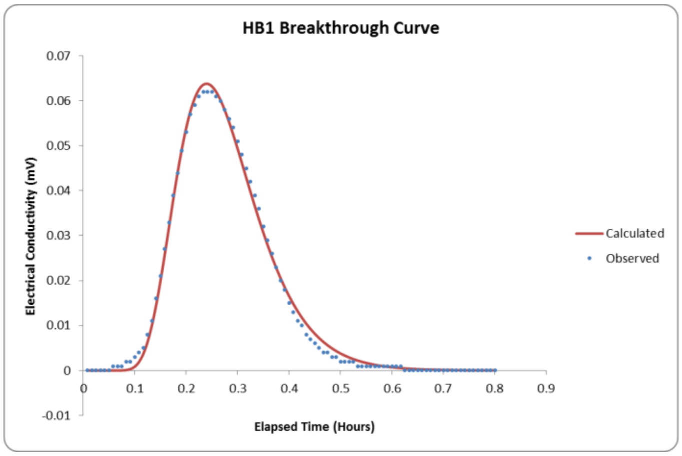
APPENDIX C

VelProbe Data Analysis

VELPROBE OUTPUT

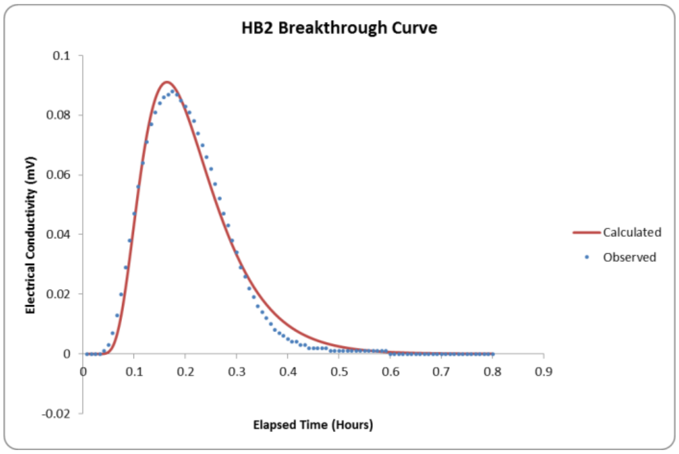
6 cm PVP Data for Medium Sand

VelProbe output for 03262013_6cm_1316_medsand_15_1gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			365.1139	15.21308		
DISPERSIVITY (cm)			0.193404			
PULSE WIDTH (cm)			0.028414			
RF			1			
Co (mV)			6.675189			
RESDIUAL SUM OF SQUARES =				0.000138		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.02			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		365.1139	365.1139	365.1139		
DISPERSIVITY(cm)		0.185668	0.193404	0.20114		
PULSE WIDTH (cm)		0.02813	0.028414	0.028698		
Co(mV)		6.608437	6.675189	6.741941		
CRITICAL RSS VALUE =			0.00016			

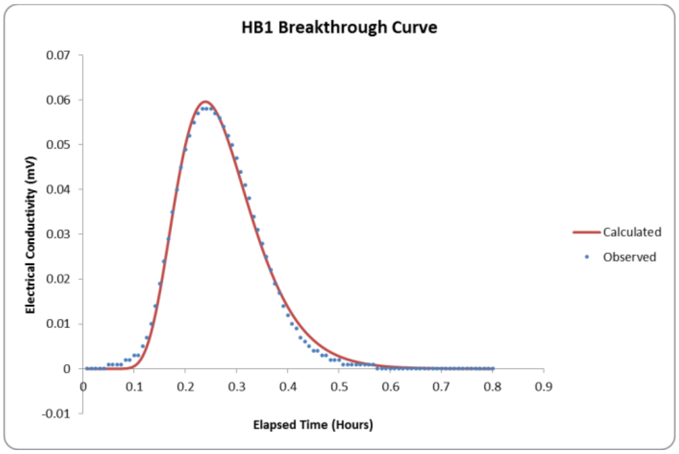
VelProbe output for 03262013_6cm_1316_medsand_15_1gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			307.2121	12.8005		
DISPERSIVITY (cm)			0.221114			
PULSE WIDTH (cm)			0.047209			
RF			1			
Co (mV)			4.638901			
RESDIUAL SUM OF SQUARES =				0.00086		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		304.14	307.2121	310.2842		
DISPERSIVITY(cm)		0.205636	0.221114	0.236592		
PULSE WIDTH (cm)		0.045792	0.047209	0.048625		
Co(mV)		4.499734	4.638901	4.778068		
CRITICAL RSS VALUE =			0.000999			

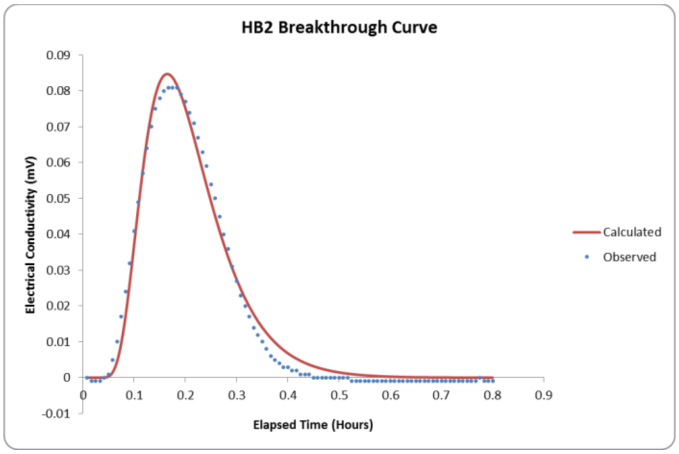
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.193404154	0.221113646	76.776345	48.128455	17.811874	365.1139	307.2121	237.0365	237.0365	0	.	1.34	0.84	0.310817	17.80851	237.0365	237.0365
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 03262013_6cm_1404_medsand_15_1gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			368.2836	15.34515		
DISPERSIVITY (cm)			0.179863			
PULSE WIDTH (cm)			0.035375			
RF			1			
Co (mV)			4.845727			
RESDIUAL SUM OF SQUARES =				0.000141		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.02			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		368.2836	368.2836	368.2836		
DISPERSIVITY(cm)		0.172668	0.179863	0.187057		
PULSE WIDTH (cm)		0.034667	0.035375	0.035729		
Co(mV)		4.748813	4.845727	4.942642		
CRITICAL RSS VALUE =			0.000164			

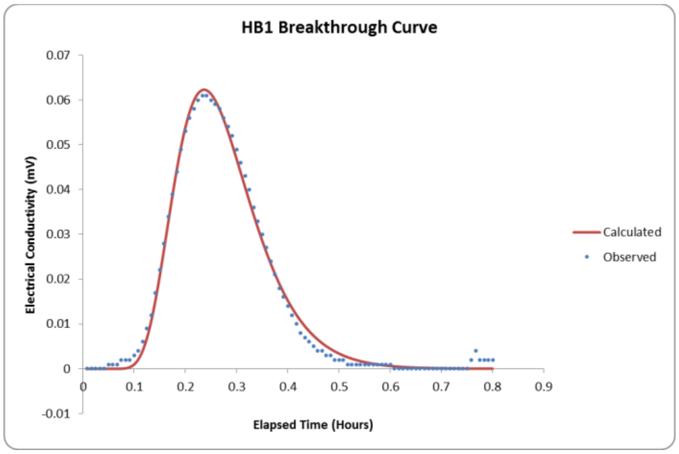
VelProbe output for 03262013_6cm_1404_medsand_15_1gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			312.5505	13.02294		
DISPERSIVITY (cm)			0.195928			
PULSE WIDTH (cm)			0.031637			
RF			1			
Co (mV)			6.138975			
RESDIUAL SUM OF SQUARES =				0.0008		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		309.425	312.5505	315.676		
DISPERSIVITY(cm)		0.182213	0.195928	0.211602		
PULSE WIDTH (cm)		0.030688	0.031637	0.032586		
Co(mV)		5.954805	6.138975	6.323144		
CRITICAL RSS VALUE =			0.00093			

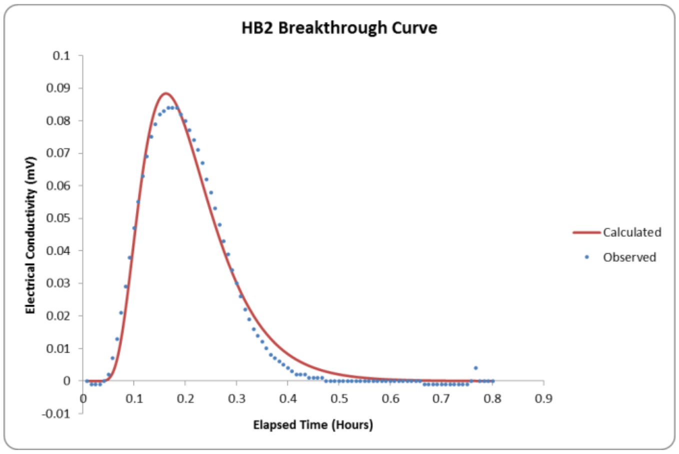
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.179862716	0.195927952	76.776345	48.128455	18.933792	368.2836	312.5505	236.0458	236.0458	0	.	1.34	0.84	0.330395	18.93022	236.0458	236.0458
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 03262013_6cm_1450_medsand_15_1gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			369.3802	15.39084		
DISPERSIVITY (cm)			0.194032			
PULSE WIDTH (cm)			0.027482			
RF			1			
Co (mV)			6.746338			
RESDIUAL SUM OF SQUARES =				0.00019		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.02			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		369.3802	369.3802	369.3802		
DISPERSIVITY(cm)		0.184331	0.194032	0.203734		
PULSE WIDTH (cm)		0.026932	0.027482	0.028031		
Co(mV)		6.611411	6.746338	6.881264		
CRITICAL RSS VALUE =			0.000221			

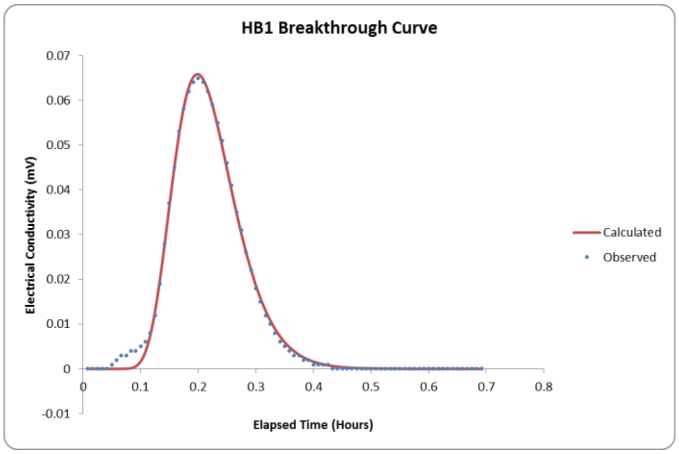
VelProbe output for 03262013_6cm_1450_medsand_15_1gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			312.4388	13.01828		
DISPERSIVITY (cm)			0.21557			
PULSE WIDTH (cm)			0.029372			
RF			1			
Co (mV)			7.159106			
RESDIUAL SUM OF SQUARES =				0.00094		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		306.19	312.4388	315.5631		
DISPERSIVITY(cm)		0.198325	0.21557	0.232816		
PULSE WIDTH (cm)		0.02849	0.029372	0.030253		
Co(mV)		6.944333	7.159106	7.373879		
CRITICAL RSS VALUE =			0.001092			

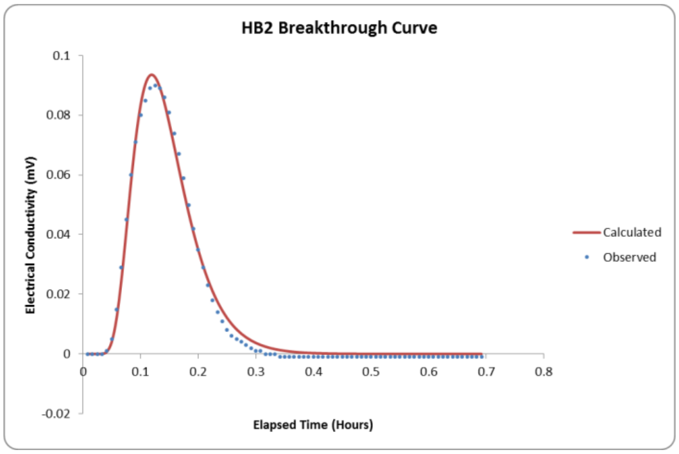
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.194032231	0.215570184	76.776345	48.128455	18.493898	369.3802	312.4388	237.9273	237.9273	0	.	1.34	0.84	0.322719	18.49041	237.9273	237.9273
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 03262013_6cm_1548_medsand_45_1gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			453.6296	18.90123		
DISPERSIVITY (cm)			0.134231			
PULSE WIDTH (cm)			0.027622			
RF			1			
Co (mV)			5.994093			
RESDIUAL SUM OF SQUARES =				8.85E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.02			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		453.6296	453.6296	453.6296		
DISPERSIVITY(cm)		0.128862	0.134231	0.1396		
PULSE WIDTH (cm)		0.027346	0.027622	0.027898		
Co(mV)		5.934152	5.994093	6.054034		
CRITICAL RSS VALUE =			0.000105			

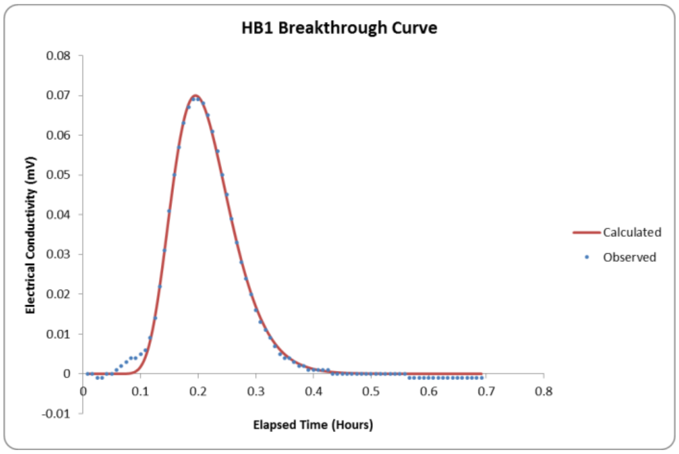
VelProbe output for 03262013_6cm_1548_medsand_45_1gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			442.3622	18.43176		
DISPERSIVITY (cm)			0.167501			
PULSE WIDTH (cm)			0.034158			
RF			1			
Co (mV)			5.872899			
RESDIUAL SUM OF SQUARES =				0.000403		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		437.9386	442.3622	446.7859		
DISPERSIVITY(cm)		0.157451	0.167501	0.179226		
PULSE WIDTH (cm)		0.033133	0.034158	0.034841		
Co(mV)		5.696712	5.872899	5.990357		
CRITICAL RSS VALUE =			0.00048			

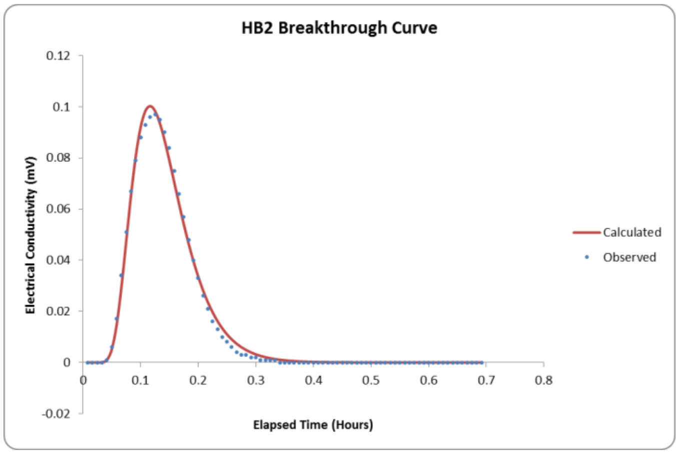
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.134230766	0.167501197	76.776345	48.128455	42.897061	453.6296	442.3622	247.5808	247.5808	-5.74E-15	.	1.34	0.84	0.748554	42.88897	247.5808	247.5808
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 03262013_6cm_1706_medsand_45_1gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			462.5182	19.27159		
DISPERSIVITY (cm)			0.128791			
PULSE WIDTH (cm)			0.031927			
RF			1			
Co (mV)			5.407898			
RESDIUAL SUM OF SQUARES =				8.53E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.02			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		462.5182	462.5182	462.5182		
DISPERSIVITY(cm)		0.124927	0.128791	0.133943		
PULSE WIDTH (cm)		0.031608	0.031927	0.032247		
Co(mV)		5.353819	5.407898	5.461977		
CRITICAL RSS VALUE =			0.000101			

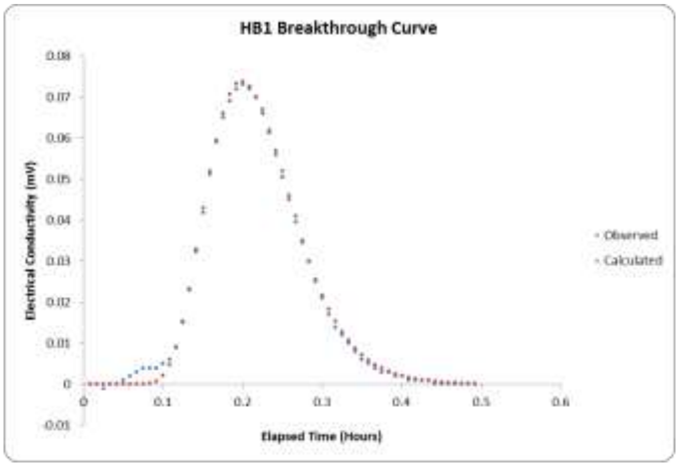
VelProbe output for 03262013_6cm_1706_medsand_45_1gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES					
			cm/hr		
VELOCITY(cm/d)		453.7271	18.9053		
DISPERSIVITY (cm)		0.16522			
PULSE WIDTH (cm)		0.02766			
RF		1			
Co (mV)		7.728672			
RESDIUAL SUM OF SQUARES =			0.000297		
INITIAL GUESSES AND INPUT OF PARAMETERS					
					FIX
VELOCITY(cm/d)		300			
DISPERSIVITY (cm)		0.1			
PULSE WIDTH (cm)		0.01			
RF		1			Y
Co (mV)		2			
DISTANCE FROM SOURCE (cm)		2.52			Y
DIFFUSION COEFF (cm^2/sec)		0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS					
Parameter	Low	Optimized	High		
VELOCITY(cm/d)	449.1898	453.7271	458.2644		
DISPERSIVITY(cm)	0.156959	0.16522	0.173481		
PULSE WIDTH (cm)	0.027107	0.02766	0.028214		
Co(mV)	7.574099	7.728672	7.883246		
CRITICAL RSS VALUE =		0.000353			

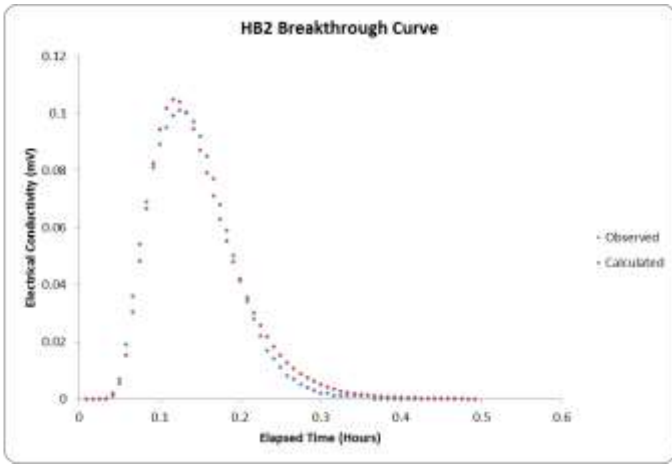
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.12879096	0.165220135	76.776345	48.128455	44.160895	462.5182	453.7271	251.6418	251.6418	-5.647E-15	.	1.34	0.84	0.770608	44.15256	251.6418	251.6418
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 03262013_6cm_1753_medsand_45_1gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
VELOCITY(cm/d)			459.7873			
DISPERSIVITY (cm)			0.141291			
PULSE WIDTH (cm)			0.032208			
RF			1			
Co (mV)			5.946087			
RESDIUAL SUM OF SQUARES =				9.44E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.38			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		459.7873	459.7873	459.7873		
DISPERSIVITY(cm)		0.13564	0.141291	0.146943		
PULSE WIDTH (cm)		0.031564	0.032208	0.032852		
Co(mV)		5.827165	5.946087	6.065008		
CRITICAL RSS VALUE =			0.00012			

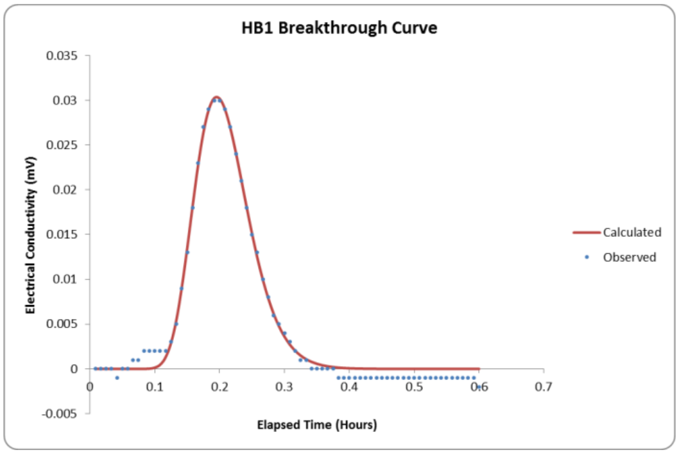
VelProbe output for 03262013_6cm_1753_medsand_45_1gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
VELOCITY(cm/d)			439.3517			
DISPERSIVITY (cm)			0.178312			
PULSE WIDTH (cm)			0.034565			
RF			1			
Co (mV)			6.677714			
RESDIUAL SUM OF SQUARES =				0.000531		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.38			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		434.9582	439.3517	443.7452		
DISPERSIVITY(cm)		0.16583	0.178312	0.192577		
PULSE WIDTH (cm)		0.033528	0.034565	0.035601		
Co(mV)		6.477382	6.677714	6.878045		
CRITICAL RSS VALUE =			0.000676			

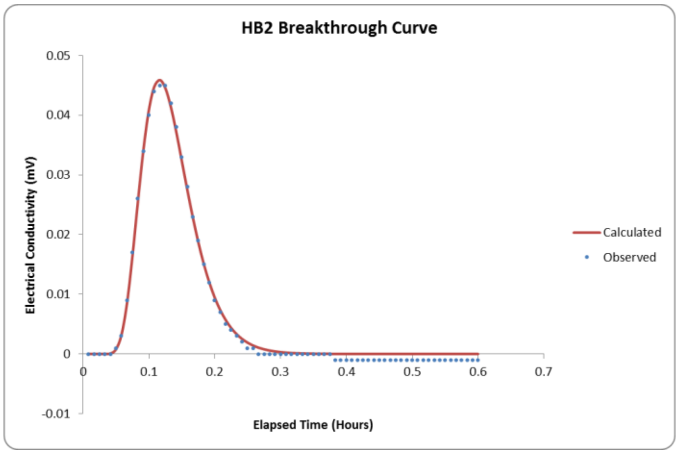
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference
Probe 1	0.178311755	0.141291157	48.137536	77.936963	38.699799	439.3517	459.7873	254.5014	254.5014	-2.792E-15
Probe 2	0.178311755	0.141291157	48.137536	77.936963	40.649489	443.7452	459.7873	252.7657	252.7657	0
Probe 3	0.178311755	0.141291157	48.137536	77.936963	36.77871	434.9582	459.7873	256.5274	256.5274	0
Probe 4	0	0	0	0	0	0	0	65535	65535	65535
Probe 5	0	0	0	0	0	0	0	65535	65535	65535
Probe 6	0	0	0	0	0	0	0	65535	65535	65535
Probe 7	0	0	0	0	0	0	0	65535	65535	65535
Probe 8	0	0	0	0	0	0	0	65535	65535	65535

VelProbe output for 03262013_6cm_1826_medsand_45_1gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			472.6124	19.69218		
DISPERSIVITY (cm)			0.086294			
PULSE WIDTH (cm)			0.015547			
RF			1			
Co (mV)			3.991795			
RESDIUAL SUM OF SQUARES =				5.15E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.02			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		467.8863	472.6124	477.3385		
DISPERSIVITY(cm)		0.079391	0.086294	0.094061		
PULSE WIDTH (cm)		0.015081	0.015547	0.016013		
Co(mV)		3.872041	3.991795	4.111549		
CRITICAL RSS VALUE =			6.29E-05			

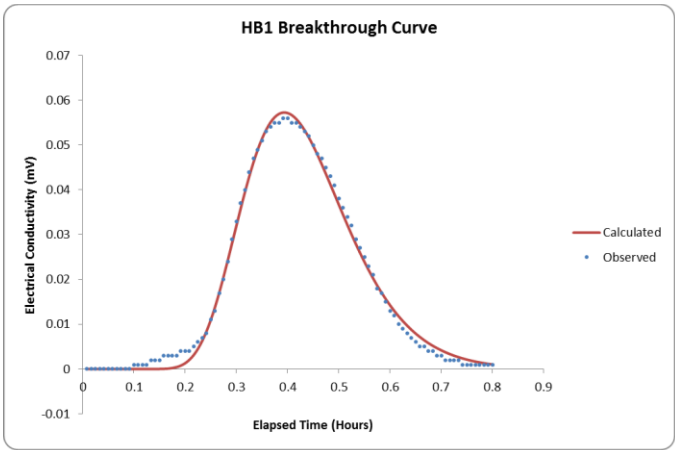
VelProbe output for 03262013_6cm_1826_medsand_45_1gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			473.9144	19.74643		
DISPERSIVITY (cm)			0.117284			
PULSE WIDTH (cm)			0.023747			
RF			1			
Co (mV)			3.546705			
RESDIUAL SUM OF SQUARES =				3.72E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		473.9144	473.9144	473.9144		
DISPERSIVITY(cm)		0.112593	0.117284	0.123148		
PULSE WIDTH (cm)		0.023272	0.023747	0.024222		
Co(mV)		3.47577	3.546705	3.617639		
CRITICAL RSS VALUE =			4.53E-05			

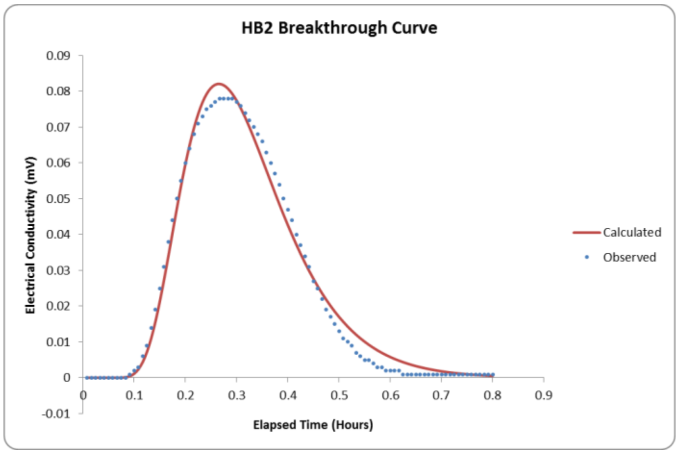
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.117284137	0.08629412	48.128455	76.776345	48.932681	473.9144	472.6124	255.2386	255.2386	5.568E-15	.	0.84	1.34	0.853875	48.92345	255.2386	255.2386
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 03272013_6cm_1559_medsand_30_1gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			229.7904	9.574602		
DISPERSIVITY (cm)			0.127371			
PULSE WIDTH (cm)			0.0333			
RF			1			
Co (mV)			4.220865			
RESDIUAL SUM OF SQUARES =				0.000169		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.02			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		229.7904	229.7904	229.7904		
DISPERSIVITY(cm)		0.122276	0.127371	0.132466		
PULSE WIDTH (cm)		0.032967	0.0333	0.033633		
Co(mV)		4.178656	4.220865	4.305282		
CRITICAL RSS VALUE =			0.000196			

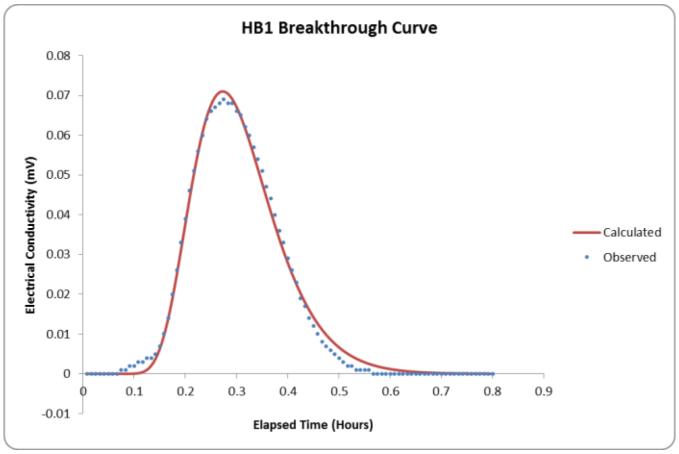
VelProbe output for 03272013_6cm_1559_medsand_30_1gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			200.2249	8.342704		
DISPERSIVITY (cm)			0.158158			
PULSE WIDTH (cm)			0.029787			
RF			1			
Co (mV)			5.770509			
RESDIUAL SUM OF SQUARES =				0.000822		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		198.2226	200.2249	202.2271		
DISPERSIVITY(cm)		0.148668	0.158158	0.169229		
PULSE WIDTH (cm)		0.028893	0.029787	0.030681		
Co(mV)		5.597394	5.770509	5.943624		
CRITICAL RSS VALUE =			0.000955			

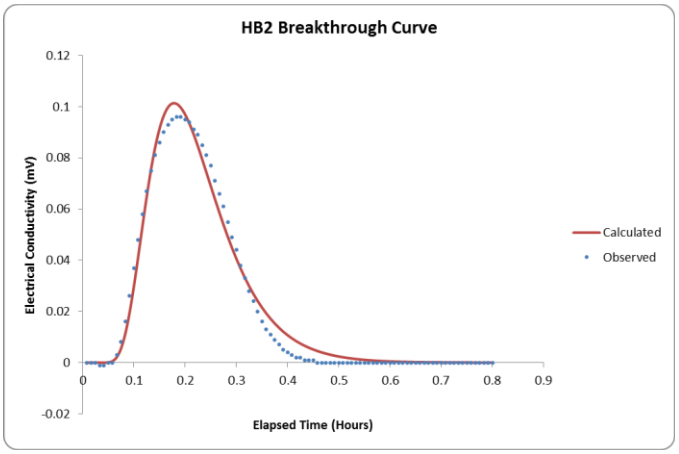
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.127371304	0.158157764	76.776345	48.128455	22.626909	229.7904	200.2249	141.7197	141.7197	0	.	1.34	0.84	0.39484	22.62264	141.7197	141.7197
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

Velprobe output for 03272013_6cm_1653_medsand_30_1gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			326.5918	13.60799		
DISPERSIVITY (cm)			0.155577			
PULSE WIDTH (cm)			0.08914			
RF			1			
Co (mV)			2.137753			
RESDIUAL SUM OF SQUARES =				0.000257		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.02			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		326.5918	326.5918	326.5918		
DISPERSIVITY(cm)		0.149353	0.155577	0.163355		
PULSE WIDTH (cm)		0.087357	0.08914	0.090923		
Co(mV)		2.094998	2.137753	2.180509		
CRITICAL RSS VALUE =			0.000298			

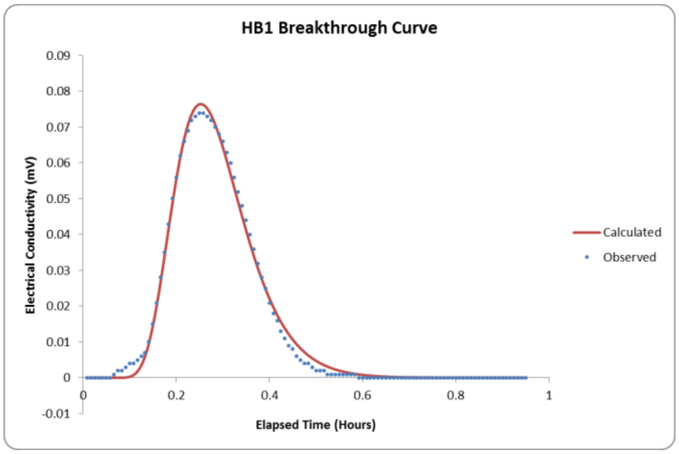
Velprobe output for 03272013_6cm_1653_medsand_30_1gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			292.1085	12.17119		
DISPERSIVITY (cm)			0.181869			
PULSE WIDTH (cm)			0.044205			
RF			1			
Co (mV)			5.085339			
RESDIUAL SUM OF SQUARES =				0.001379		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		289.1874	292.1085	295.0296		
DISPERSIVITY(cm)		0.167319	0.181869	0.198237		
PULSE WIDTH (cm)		0.042879	0.044205	0.045531		
Co(mV)		4.932779	5.085339	5.237899		
CRITICAL RSS VALUE =			0.001602			

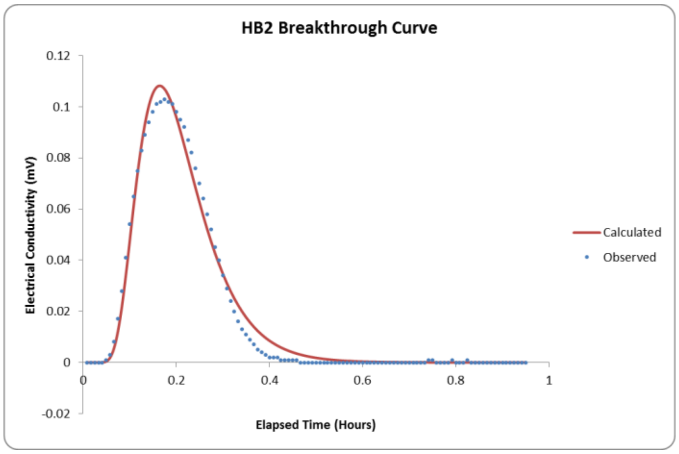
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.15557653	0.181868884	76.776345	48.128455	26.67791	326.5918	292.1085	194.3019	194.3019	-7.314E-15	.	1.34	0.84	0.46553	26.67288	194.3019	194.3019
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 03272013_6cm_1742_medsand_30_1gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			350.4712	14.60297		
DISPERSIVITY (cm)			0.169014			
PULSE WIDTH (cm)			0.02585			
RF			1			
Co (mV)			8.288856			
RESDIUAL SUM OF SQUARES =				0.000277		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.02			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		350.4712	350.4712	350.4712		
DISPERSIVITY(cm)		0.162253	0.169014	0.175774		
PULSE WIDTH (cm)		0.025333	0.02585	0.026108		
Co(mV)		8.123079	8.288856	8.371744		
CRITICAL RSS VALUE =			0.000314			

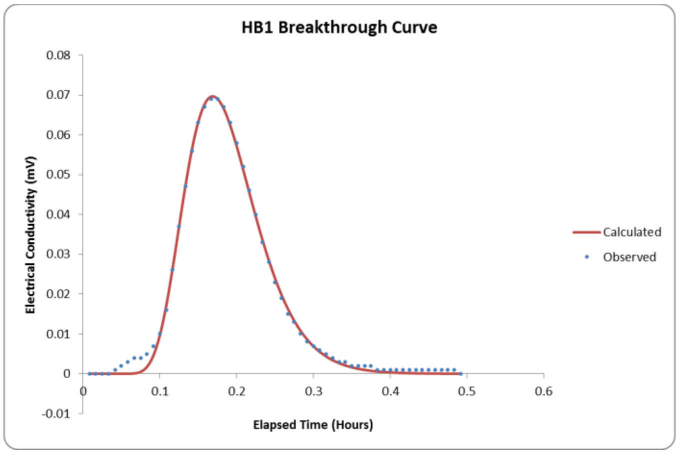
VelProbe output for 03272013_6cm_1742_medsand_30_1gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			312.9892	13.04122		
DISPERSIVITY (cm)			0.19439			
PULSE WIDTH (cm)			0.03327			
RF			1			
Co (mV)			7.425322			
RESDIUAL SUM OF SQUARES =				0.001456		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		309.8594	312.9892	316.1191		
DISPERSIVITY(cm)		0.180782	0.19439	0.207997		
PULSE WIDTH (cm)		0.032272	0.03327	0.034268		
Co(mV)		7.202562	7.425322	7.648081		
CRITICAL RSS VALUE =			0.001653			

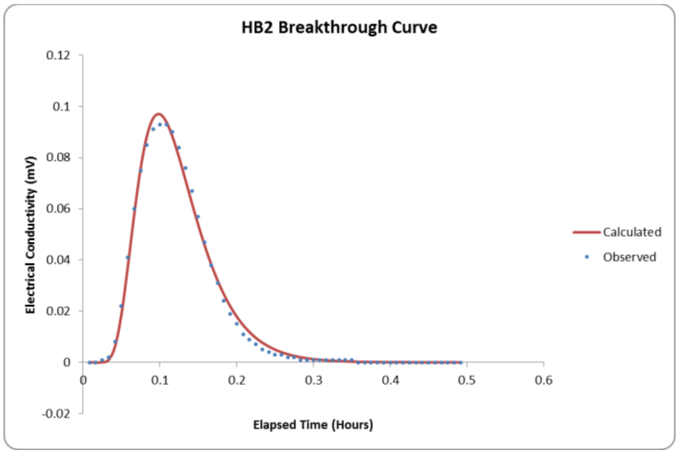
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.169013602	0.194389553	76.776345	48.128455	26.430763	350.4712	312.9892	208.9296	208.9296	6.802E-15	.	1.34	0.84	0.461217	26.42578	208.9296	208.9296
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 03282013_6cm_1202_medsand_45_1gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			531.1879	22.13283		
DISPERSIVITY (cm)			0.143695			
PULSE WIDTH (cm)			0.050636			
RF			1			
Co (mV)			3.56501			
RESDIUAL SUM OF SQUARES =				8.3E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.02			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		531.1879	531.1879	531.1879		
DISPERSIVITY(cm)		0.137947	0.143695	0.15088		
PULSE WIDTH (cm)		0.049623	0.050636	0.051648		
Co(mV)		3.49371	3.56501	3.636311		
CRITICAL RSS VALUE =			0.000106			

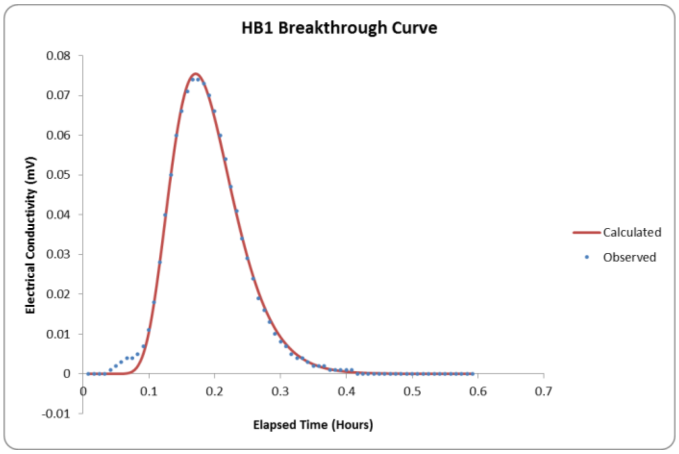
VelProbe output for 03282013_6cm_1202_medsand_45_1gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			528.6955	22.02898		
DISPERSIVITY (cm)			0.185648			
PULSE WIDTH (cm)			0.030535			
RF			1			
Co (mV)			7.113023			
RESDIUAL SUM OF SQUARES =				0.000236		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		523.4085	528.6955	533.9824		
DISPERSIVITY(cm)		0.17451	0.185648	0.196787		
PULSE WIDTH (cm)		0.029925	0.030535	0.031146		
Co(mV)		6.970762	7.113023	7.255283		
CRITICAL RSS VALUE =			0.0003			

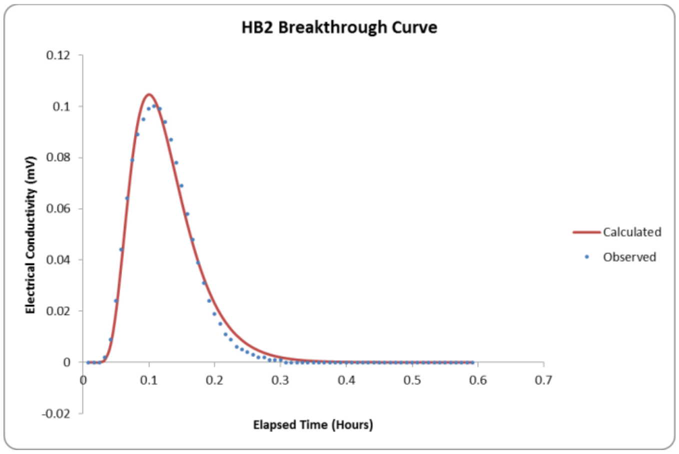
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.143694847	0.185648451	76.776345	48.128455	47.292191	531.1879	528.6955	287.3768	287.3768	-4.945E-15	.	1.34	0.84	0.825249	47.28327	287.3768	287.3768
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 03282013_6cm_1232_medsand_45_1gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			522.4474	21.76864		
DISPERSIVITY (cm)			0.15049			
PULSE WIDTH (cm)			0.029167			
RF			1			
Co (mV)			6.855428			
RESDIUAL SUM OF SQUARES =				8.38E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.02			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		522.4474	522.4474	522.4474		
DISPERSIVITY(cm)		0.14447	0.15049	0.156509		
PULSE WIDTH (cm)		0.028875	0.029167	0.029458		
Co(mV)		6.786874	6.855428	6.923983		
CRITICAL RSS VALUE =			0.000102			

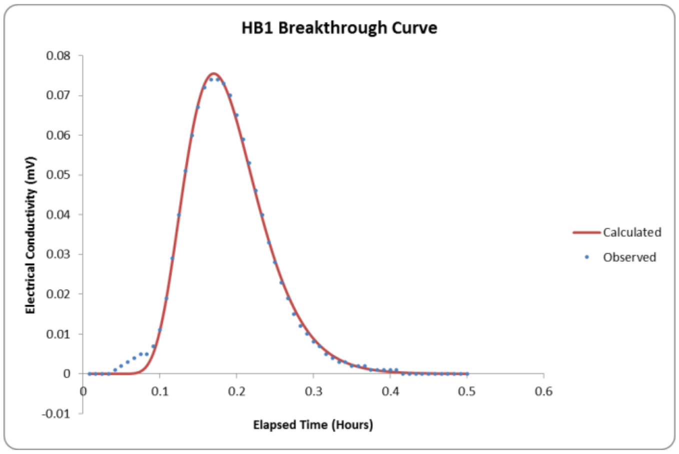
VelProbe output for 03282013_6cm_1232_medsand_45_1gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			513.8753	21.41147		
DISPERSIVITY (cm)			0.193878			
PULSE WIDTH (cm)			0.035573			
RF			1			
Co (mV)			6.712474			
RESDIUAL SUM OF SQUARES =				0.000491		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		508.7366	513.8753	519.0141		
DISPERSIVITY(cm)		0.180307	0.193878	0.209388		
PULSE WIDTH (cm)		0.034506	0.035573	0.03664		
Co(mV)		6.511099	6.712474	6.913848		
CRITICAL RSS VALUE =			0.0006			

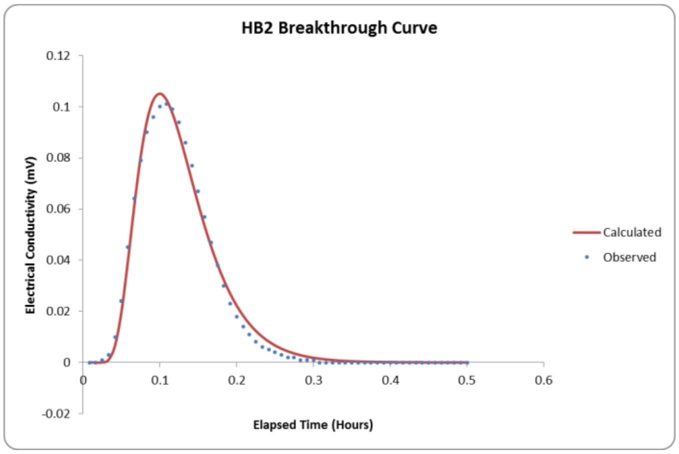
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.150489898	0.193878013	76.776345	48.128455	44.726744	522.4474	513.8753	283.8942	283.8942	-5.006E-15	.	1.34	0.84	0.780482	44.71831	283.8942	283.8942
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 03282013_6cm_1312_medsand_45_1gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			525.0675	21.87781		
DISPERSIVITY (cm)			0.150158			
PULSE WIDTH (cm)			0.03298			
RF			1			
Co (mV)			6.058967			
RESDIUAL SUM OF SQUARES =				8.39E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.02			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		525.0675	525.0675	525.0675		
DISPERSIVITY(cm)		0.144152	0.150158	0.156164		
PULSE WIDTH (cm)		0.03265	0.03298	0.03331		
Co(mV)		5.998377	6.058967	6.119556		
CRITICAL RSS VALUE =			0.000106			

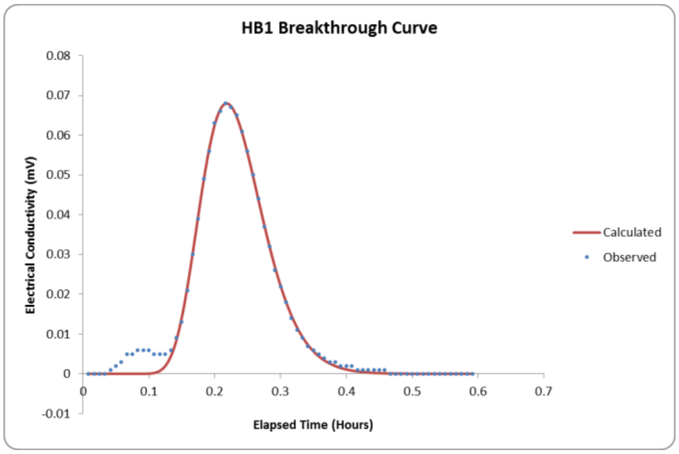
VelProbe output for 03282013_6cm_1312_medsand_45_1gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			517.4098	21.55874		
DISPERSIVITY (cm)			0.192468			
PULSE WIDTH (cm)			0.035411			
RF			1			
Co (mV)			6.744252			
RESDIUAL SUM OF SQUARES =				0.000455		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		512.2357	517.4098	522.5839		
DISPERSIVITY(cm)		0.178995	0.192468	0.207866		
PULSE WIDTH (cm)		0.034349	0.035411	0.036474		
Co(mV)		6.541924	6.744252	6.94658		
CRITICAL RSS VALUE =			0.000577			

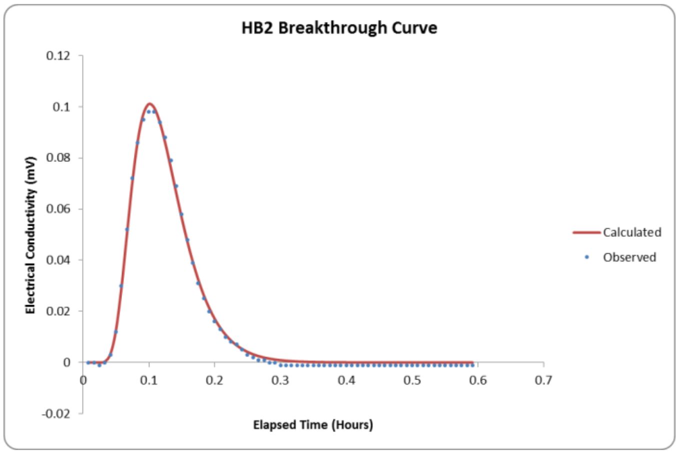
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.150157979	0.19246817	76.776345	48.128455	45.124468	525.0675	517.4098	285.0856	285.0856	4.985E-15	.	1.34	0.84	0.787422	45.11596	285.0856	285.0856
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 03282013_6cm_1351_medsand_75_1gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			422.56	17.60667		
DISPERSIVITY (cm)			0.090542			
PULSE WIDTH (cm)			0.031926			
RF			1			
Co (mV)			4.447111			
RESDIUAL SUM OF SQUARES =				0.000238		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.02			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		418.3344	422.56	422.56		
DISPERSIVITY(cm)		0.084204	0.090542	0.097785		
PULSE WIDTH (cm)		0.030968	0.031926	0.032883		
Co(mV)		4.313697	4.447111	4.580524		
CRITICAL RSS VALUE =			0.000291			

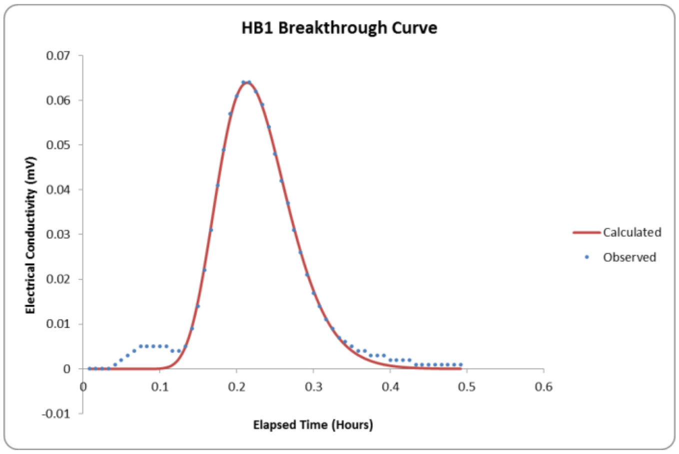
VelProbe output for 03282013_6cm_1351_medsand_75_1gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			522.0501	21.75209		
DISPERSIVITY (cm)			0.161088			
PULSE WIDTH (cm)			0.029016			
RF			1			
Co (mV)			7.346529			
RESDIUAL SUM OF SQUARES =				0.000113		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		522.0501	522.0501	522.0501		
DISPERSIVITY(cm)		0.156256	0.161088	0.165921		
PULSE WIDTH (cm)		0.028726	0.029016	0.029306		
Co(mV)		7.273064	7.346529	7.419994		
CRITICAL RSS VALUE =			0.000138			

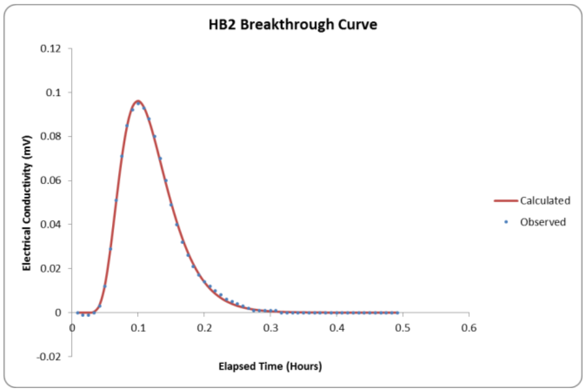
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.090541824	0.161088459	76.776345	48.128455	92.024862	422.56	522.0501	299.3173	299.3173	1.871E-12	.	1.34	0.84	-1.53576	-87.9925	-299.317	-299.317
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

Velprobe output for 03282013_6cm_1727_medsand_75_1gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			431.698	17.98742		
DISPERSIVITY (cm)			0.088773			
PULSE WIDTH (cm)			0.024932			
RF			1			
Co (mV)			5.310675			
RESDIUAL SUM OF SQUARES =				0.000201		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.02			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		427.381	431.698	436.015		
DISPERSIVITY(cm)		0.081671	0.088773	0.096763		
PULSE WIDTH (cm)		0.024184	0.024932	0.02568		
Co(mV)		5.151354	5.310675	5.469995		
CRITICAL RSS VALUE =			0.000256			

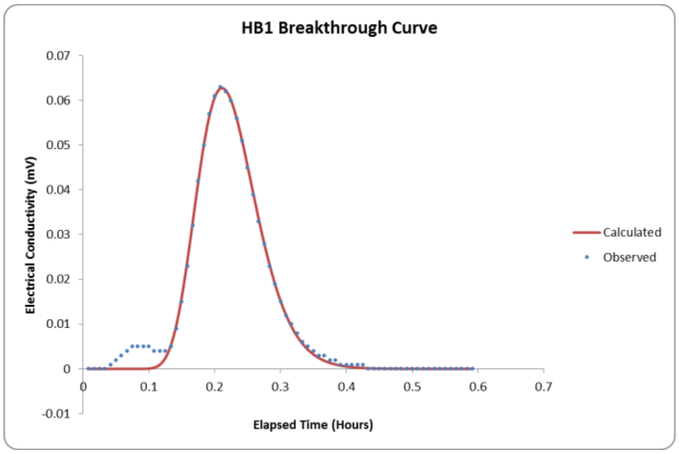
Velprobe output for 03282013_6cm_1727_medsand_75_1gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			534.6851	22.27855		
DISPERSIVITY (cm)			0.157311			
PULSE WIDTH (cm)			0.026372			
RF			1			
Co (mV)			7.613243			
RESDIUAL SUM OF SQUARES =				3.34E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		534.6851	534.6851	534.6851		
DISPERSIVITY(cm)		0.154165	0.157311	0.160457		
PULSE WIDTH (cm)		0.026108	0.026372	0.026636		
Co(mV)		7.53711	7.613243	7.689375		
CRITICAL RSS VALUE =			4.25E-05			

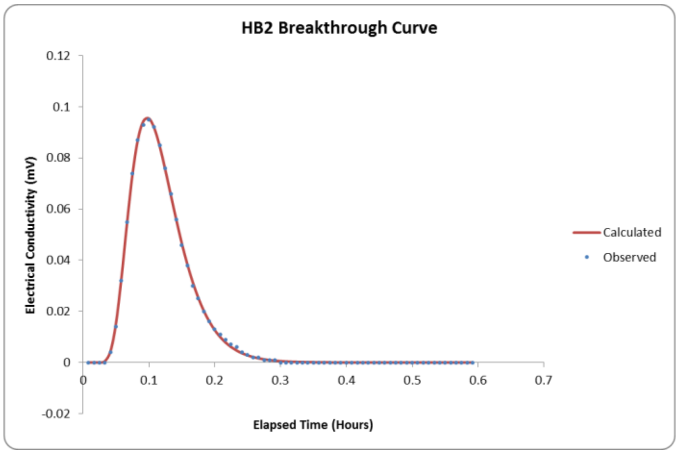
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.088773327	0.157310768	76.776345	48.128455	92.422291	431.698	534.6851	307.6128	307.6128	1.889E-12	.	1.34	0.84	-1.52882	-87.5951	-307.613	-307.613
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 03282013_6cm_1759_medsand_75_1gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			437.2159	18.21733		
DISPERSIVITY (cm)			0.086812			
PULSE WIDTH (cm)			0.024274			
RF			1			
Co (mV)			5.294251			
RESDIUAL SUM OF SQUARES =				0.000167		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.02			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		437.2159	437.2159	437.2159		
DISPERSIVITY(cm)		0.080736	0.086812	0.092889		
PULSE WIDTH (cm)		0.023546	0.024274	0.025002		
Co(mV)		5.135424	5.294251	5.453079		
CRITICAL RSS VALUE =			0.000204			

VelProbe output for 03282013_6cm_1759_medsand_75_1gL_0.5 – Half Bridge 2



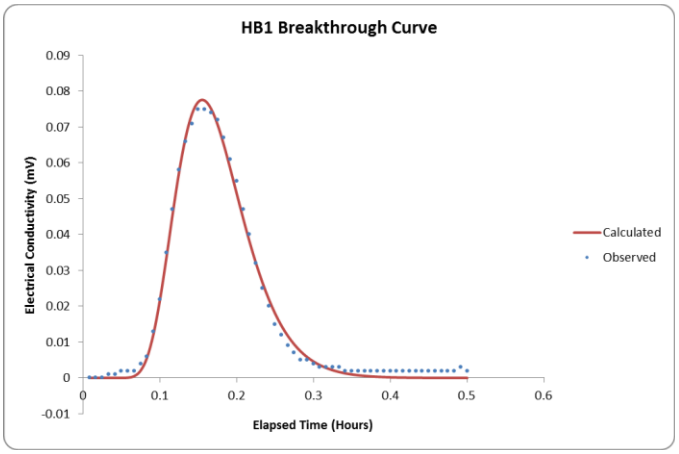
OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			544.6763	22.69485		
DISPERSIVITY (cm)			0.160079			
PULSE WIDTH (cm)			0.030593			
RF			1			
Co (mV)			6.577017			
RESDIUAL SUM OF SQUARES =				1.69E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		544.6763	544.6763	544.6763		
DISPERSIVITY(cm)		0.158478	0.160079	0.16168		
PULSE WIDTH (cm)		0.030593	0.030593	0.030593		
Co(mV)		6.577017	6.577017	6.577017		
CRITICAL RSS VALUE =			2.07E-05			

Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.086812389	0.160078961	76.776345	48.128455	93.324927	437.2159	544.6763	315.8772	315.8772	1.93E-12	.	1.34	0.84	-1.51307	-86.6927	-315.877	-315.877
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VELPROBE OUTPUT

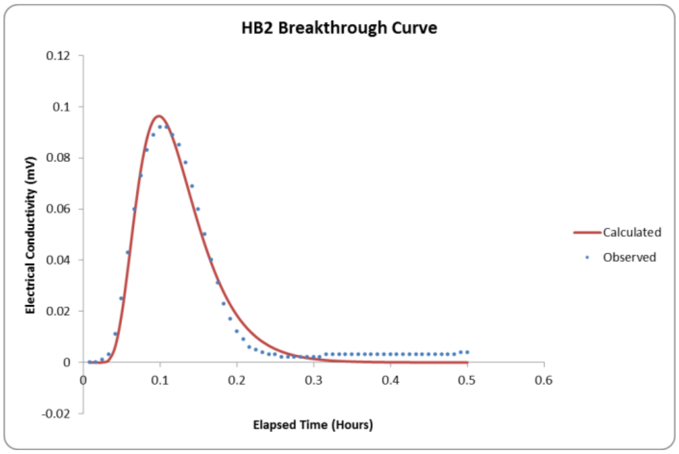
4cm PVP Data for Medium Sand

VelProbe output for 04162013_4cm_1207_medsand_45_1gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			414.5565	17.27319		
DISPERSIVITY (cm)			0.111867			
PULSE WIDTH (cm)			0.027806			
RF			1			
Co (mV)			5.409044			
RESDIUAL SUM OF SQUARES =				0.000187		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		410.4109	414.5565	418.702		
DISPERSIVITY(cm)		0.105155	0.111867	0.119698		
PULSE WIDTH (cm)		0.026971	0.027806	0.028362		
Co(mV)		5.246773	5.409044	5.517225		
CRITICAL RSS VALUE =			0.000237			

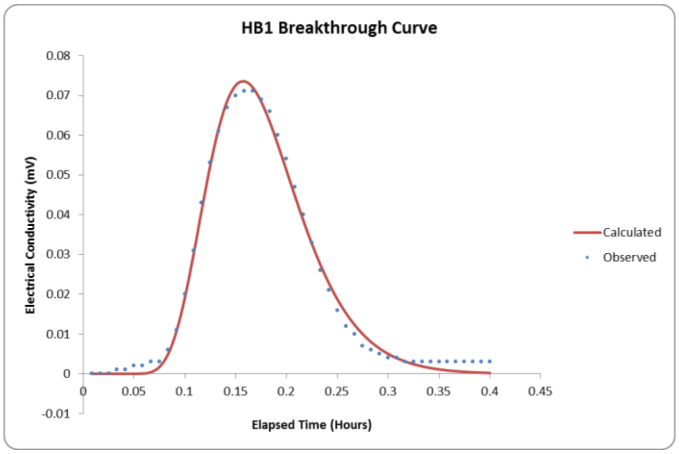
VelProbe output for 04162013_4cm_1207_medsand_45_1gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			376.5404	15.68918		
DISPERSIVITY (cm)			0.135018			
PULSE WIDTH (cm)			0.038327			
RF			1			
Co (mV)			4.054046			
RESDIUAL SUM OF SQUARES =				0.000791		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		369.0096	376.5404	384.0712		
DISPERSIVITY(cm)		0.120166	0.135018	0.152571		
PULSE WIDTH (cm)		0.03641	0.038327	0.040243		
Co(mV)		3.851343	4.054046	4.256748		
CRITICAL RSS VALUE =			0.001003			

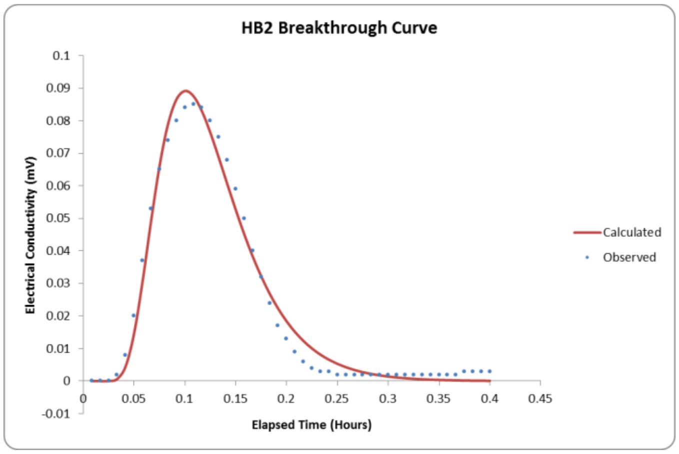
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.111867004	0.135018412	79.883539	49.582886	28.731982	414.5565	376.5404	241.6235	241.6235	-5.881E-15	.	1.394231	0.865385	0.501373	28.72656	241.6235	241.6235
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 04162013_4cm_1321_medsand_45_1gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			408.9194	17.03831		
DISPERSIVITY (cm)			0.112765			
PULSE WIDTH (cm)			0.034912			
RF			1			
Co (mV)			4.094434			
RESDIUAL SUM OF SQUARES =				0.000163		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		404.8302	408.9194	413.0086		
DISPERSIVITY(cm)		0.104871	0.112765	0.120658		
PULSE WIDTH (cm)		0.033865	0.034912	0.035959		
Co(mV)		3.971601	4.094434	4.217267		
CRITICAL RSS VALUE =			0.000218			

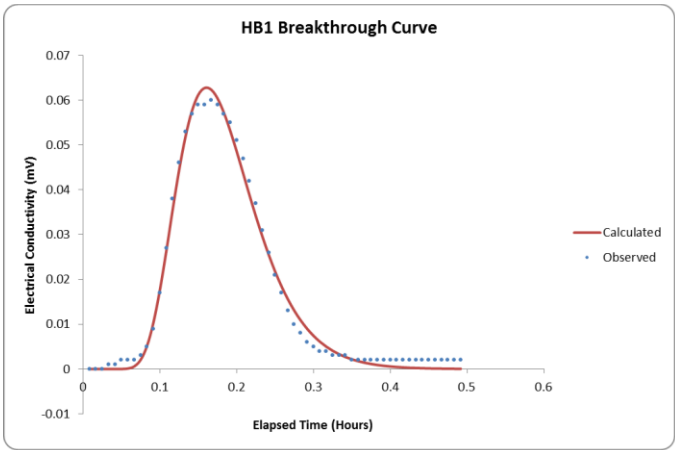
VelProbe output for 04162013_4cm_1321_medsand_45_1gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			368.6725	15.36135		
DISPERSIVITY (cm)			0.131957			
PULSE WIDTH (cm)			0.039913			
RF			1			
Co (mV)			3.564243			
RESDIUAL SUM OF SQUARES =				0.000664		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		361.299	368.6725	379.7327		
DISPERSIVITY(cm)		0.116122	0.131957	0.150431		
PULSE WIDTH (cm)		0.037917	0.039913	0.041909		
Co(mV)		3.386031	3.564243	3.742455		
CRITICAL RSS VALUE =			0.000892			

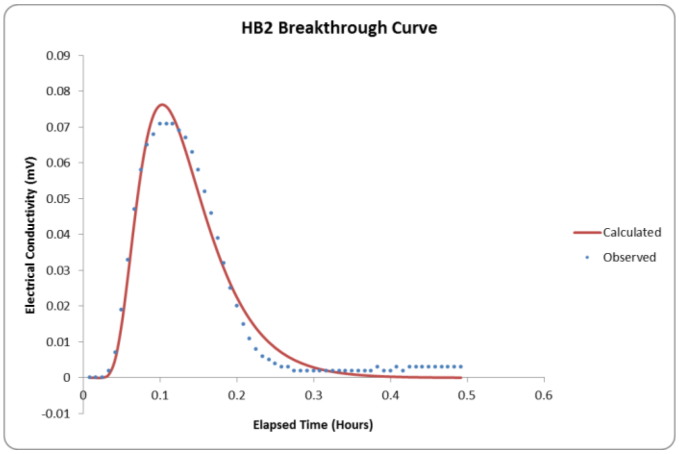
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.112764609	0.131957337	79.883539	49.582886	27.527201	408.9194	368.6725	240.3643	240.3643	0	.	1.394231	0.865385	0.48035	27.52201	240.3643	240.3643
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 04162013_4cm_1346_medsand_45_1gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			394.5167	16.4382		
DISPERSIVITY (cm)			0.131529			
PULSE WIDTH (cm)			0.024107			
RF			1			
Co (mV)			5.43823			
RESDIUAL SUM OF SQUARES =				0.000184		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		390.5715	394.5167	398.4618		
DISPERSIVITY(cm)		0.122322	0.131529	0.142051		
PULSE WIDTH (cm)		0.023384	0.024107	0.02483		
Co(mV)		5.275083	5.43823	5.601377		
CRITICAL RSS VALUE =			0.000235			

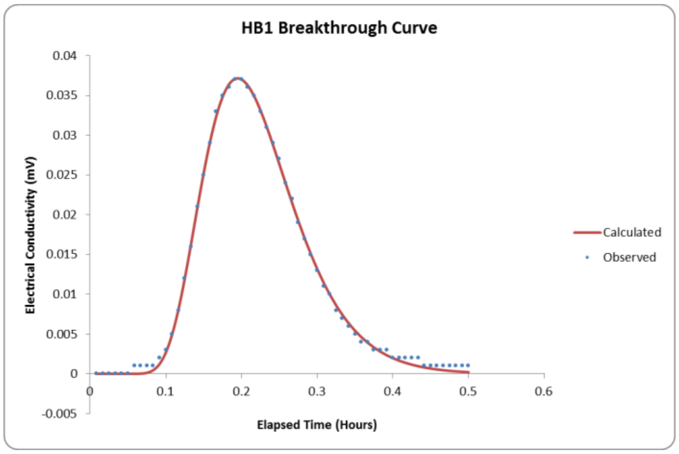
VelProbe output for 04162013_4cm_1346_medsand_45_1gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			349.4789	14.56162		
DISPERSIVITY (cm)			0.159977			
PULSE WIDTH (cm)			0.058648			
RF			1			
Co (mV)			2.236858			
RESDIUAL SUM OF SQUARES =				0.000627		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		338.9946	349.4789	359.9633		
DISPERSIVITY(cm)		0.142379	0.159977	0.180774		
PULSE WIDTH (cm)		0.055716	0.058648	0.061581		
Co(mV)		2.125015	2.236858	2.348701		
CRITICAL RSS VALUE =			0.000798			

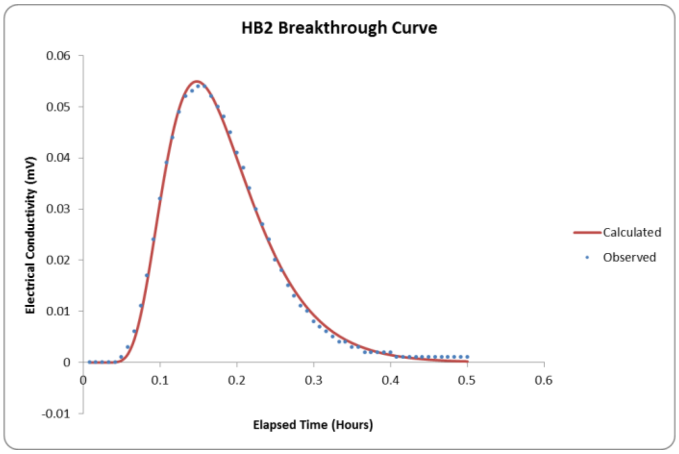
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.131528939	0.159976762	79.883539	49.582886	24.787356	394.5167	349.4789	236.8664	236.8664	-3E-15	.	1.394231	0.865385	0.432539	24.78268	236.8664	236.8664
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 04172013_4cm_0712_medsand_15_1gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			326.3278	13.59699		
DISPERSIVITY (cm)			0.128083			
PULSE WIDTH (cm)			0.009869			
RF			1			
Co (mV)			7.772977			
RESDIUAL SUM OF SQUARES =				1.23E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		326.3278	326.3278	326.3278		
DISPERSIVITY(cm)		0.12424	0.128083	0.131925		
PULSE WIDTH (cm)		0.00977	0.009869	0.009967		
Co(mV)		7.695248	7.772977	7.850707		
CRITICAL RSS VALUE =			1.57E-05			

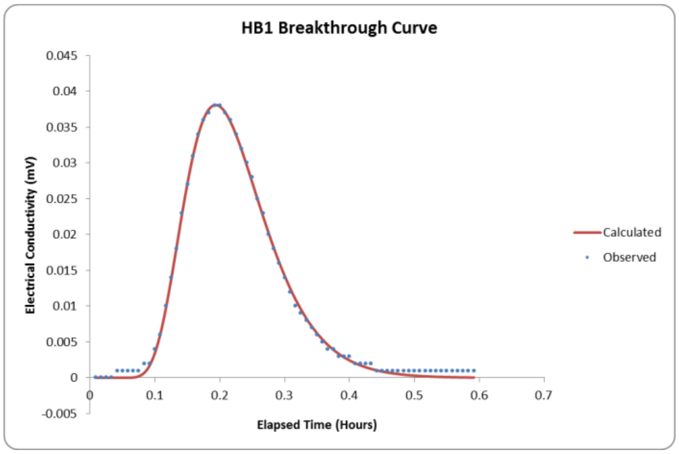
VelProbe output for 04172013_4cm_0712_medsand_15_1gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			253.3478	10.55616		
DISPERSIVITY (cm)			0.124922			
PULSE WIDTH (cm)			0.021822			
RF			1			
Co (mV)			3.93294			
RESDIUAL SUM OF SQUARES =				4.03E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		253.3478	253.3478	253.3478		
DISPERSIVITY(cm)		0.121174	0.124922	0.128669		
PULSE WIDTH (cm)		0.021604	0.021822	0.02204		
Co(mV)		3.893611	3.93294	3.97227		
CRITICAL RSS VALUE =			5.11E-05			

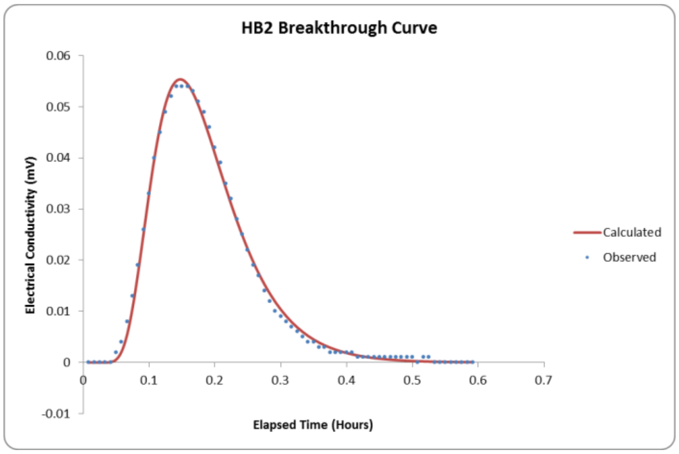
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.128082511	0.12492181	79.883539	49.582886	9.0278773	326.3278	253.3478	234.8655	234.8655	-3.025E-15	.	1.394231	0.865385	0.157536	9.026174	234.8655	234.8655
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 04172013_4cm_0815_medsand_15_1gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			326.119	13.58829		
DISPERSIVITY (cm)			0.139025			
PULSE WIDTH (cm)			0.024068			
RF			1			
Co (mV)			3.388304			
RESDIUAL SUM OF SQUARES =				2.2E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		326.119	326.119	326.119		
DISPERSIVITY(cm)		0.134854	0.139025	0.143195		
PULSE WIDTH (cm)		0.023827	0.024068	0.024309		
Co(mV)		3.354421	3.388304	3.422187		
CRITICAL RSS VALUE =			2.69E-05			

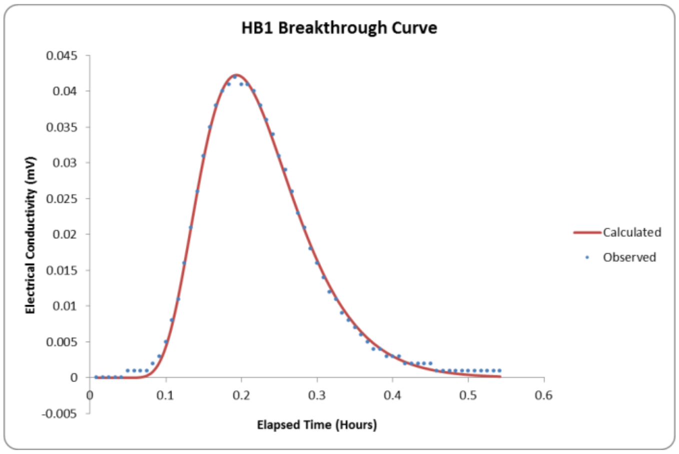
VelProbe output for 04172013_4cm_0815_medsand_15_1gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			251.5212	10.48005		
DISPERSIVITY (cm)			0.133288			
PULSE WIDTH (cm)			0.021791			
RF			1			
Co (mV)			4.075963			
RESDIUAL SUM OF SQUARES =				6.25E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		251.5212	251.5212	254.0364		
DISPERSIVITY(cm)		0.127957	0.133288	0.13862		
PULSE WIDTH (cm)		0.021574	0.021791	0.022009		
Co(mV)		4.035203	4.075963	4.116723		
CRITICAL RSS VALUE =			7.64E-05			

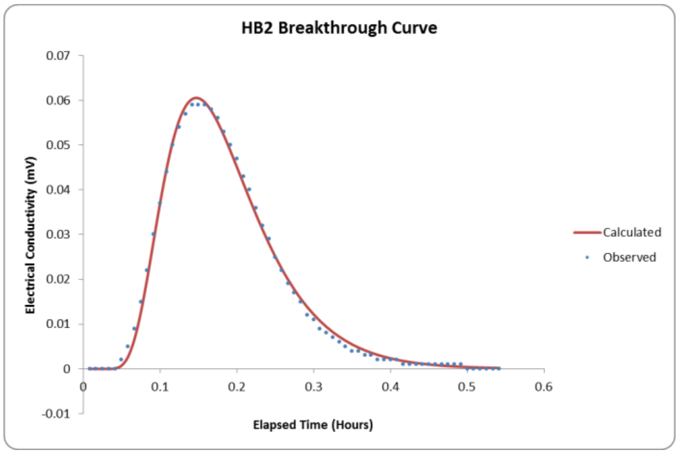
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.139024647	0.133288088	79.883539	49.582886	8.4282306	326.119	251.5212	236.8853	236.8853	-3E-15	.	1.394231	0.865385	0.147073	8.426641	236.8853	236.8853
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 04172013_4cm_1008_medsand_15_1gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			325.0616	13.54423		
DISPERSIVITY (cm)			0.145177			
PULSE WIDTH (cm)			0.026925			
RF			1			
Co (mV)			3.42692			
RESDIUAL SUM OF SQUARES =				1.94E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		325.0616	325.0616	325.0616		
DISPERSIVITY(cm)		0.140822	0.145177	0.149532		
PULSE WIDTH (cm)		0.026655	0.026925	0.027194		
Co(mV)		3.392651	3.42692	3.461189		
CRITICAL RSS VALUE =			2.42E-05			

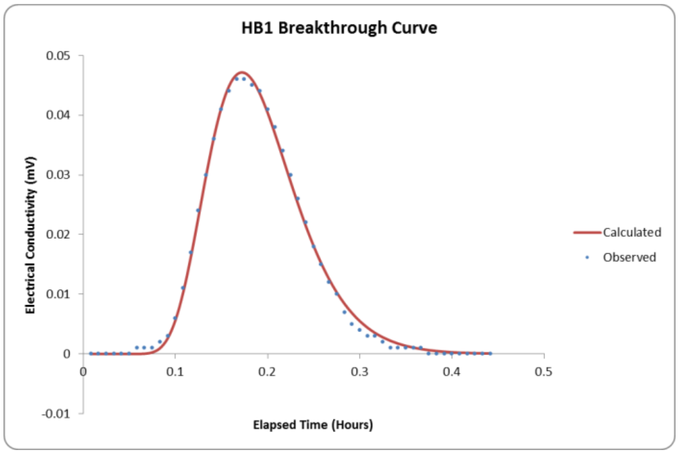
VelProbe output for 04172013_4cm_1008_medsand_15_1gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			250.0481	10.41867		
DISPERSIVITY (cm)			0.139414			
PULSE WIDTH (cm)			0.023388			
RF			1			
Co (mV)			4.230937			
RESDIUAL SUM OF SQUARES =				7.51E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		247.5476	250.0481	252.5486		
DISPERSIVITY(cm)		0.133838	0.139414	0.144991		
PULSE WIDTH (cm)		0.023154	0.023388	0.023622		
Co(mV)		4.188627	4.230937	4.315555		
CRITICAL RSS VALUE =			9.36E-05			

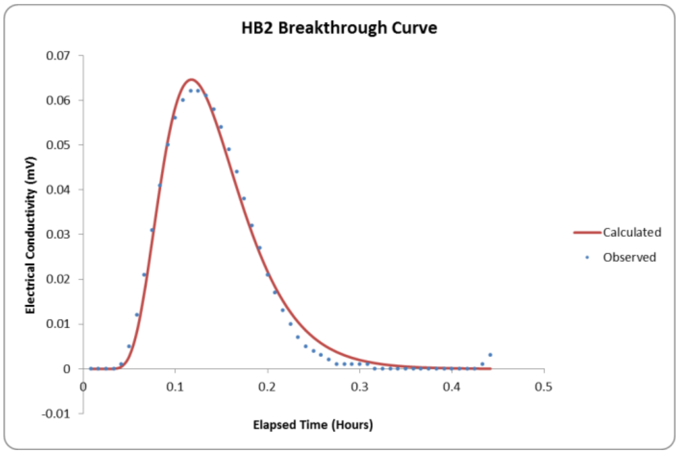
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.145176931	0.139414116	79.883539	49.582886	8.1935968	325.0616	250.0481	236.9817	236.9817	0	.	1.394231	0.865385	0.142978	8.192051	236.9817	236.9817
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 04182013_4cm_0719_medsand_30_1gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			375.9428	15.66428		
DISPERSIVITY (cm)			0.103784			
PULSE WIDTH (cm)			0.020022			
RF			1			
Co (mV)			4.415857			
RESDIUAL SUM OF SQUARES =				3.02E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		375.9428	375.9428	375.9428		
DISPERSIVITY(cm)		0.099633	0.103784	0.107936		
PULSE WIDTH (cm)		0.019622	0.020022	0.020222		
Co(mV)		4.32754	4.415857	4.504175		
CRITICAL RSS VALUE =			3.95E-05			

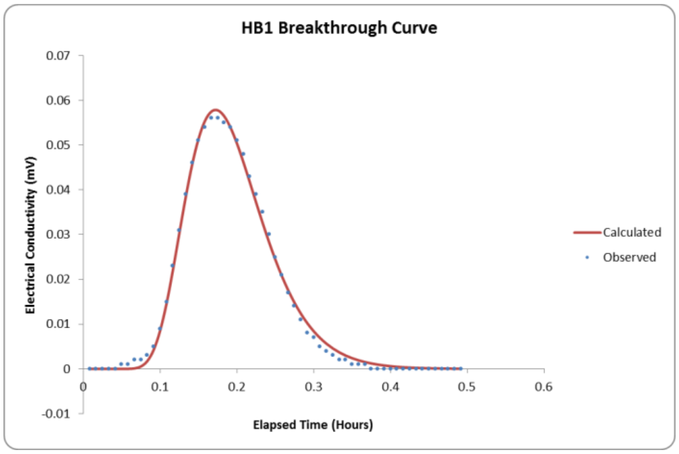
VelProbe output for 04182013_4cm_0719_medsand_30_1gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			322.8567	13.45236		
DISPERSIVITY (cm)			0.114908			
PULSE WIDTH (cm)			0.02195			
RF			1			
Co (mV)			4.435921			
RESDIUAL SUM OF SQUARES =				0.000195		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		319.6281	322.8567	326.0853		
DISPERSIVITY(cm)		0.105715	0.114908	0.125249		
PULSE WIDTH (cm)		0.021292	0.02195	0.022609		
Co(mV)		4.302843	4.435921	4.568999		
CRITICAL RSS VALUE =			0.000255			

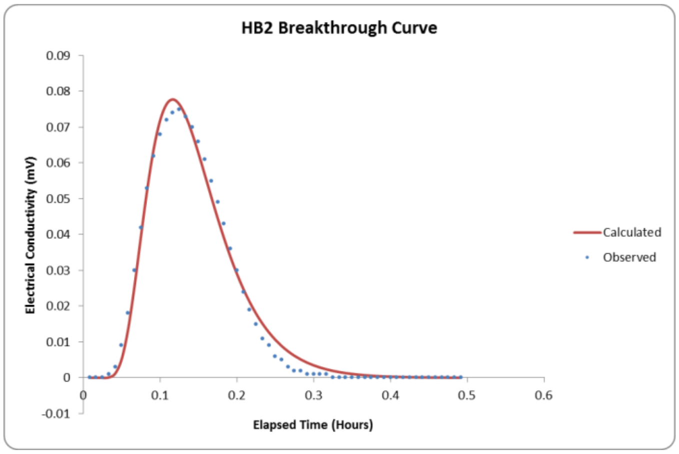
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.114907709	0.103784294	49.582886	79.883539	20.35603	322.8567	375.9428	234.9882	234.9882	0	.	0.865385	1.394231	0.355213	20.35219	234.9882	234.9882
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 04182013_4cm_0743_medsand_30_1gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			372.7821	15.53259		
DISPERSIVITY (cm)			0.115024			
PULSE WIDTH (cm)			0.023483			
RF			1			
Co (mV)			4.839001			
RESDIUAL SUM OF SQUARES =				6.76E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		372.7821	372.7821	372.7821		
DISPERSIVITY(cm)		0.110423	0.115024	0.120775		
PULSE WIDTH (cm)		0.023014	0.023483	0.023953		
Co(mV)		4.742221	4.839001	4.935781		
CRITICAL RSS VALUE =			8.6E-05			

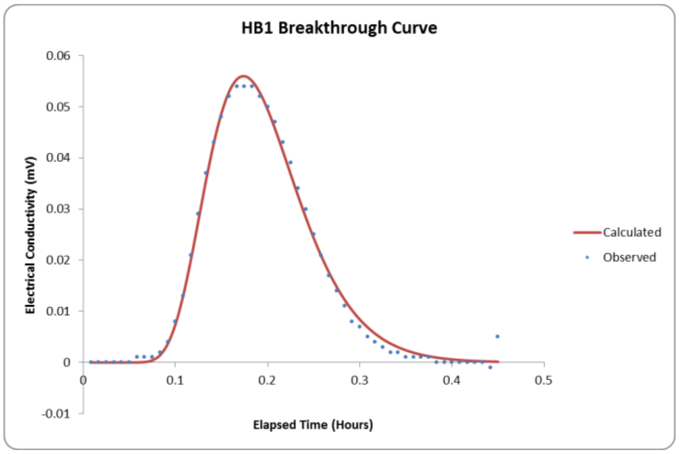
VelProbe output for 04182013_4cm_0743_medsand_30_1gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			319.6451	13.31855		
DISPERSIVITY (cm)			0.130261			
PULSE WIDTH (cm)			0.018323			
RF			1			
Co (mV)			6.744083			
RESDIUAL SUM OF SQUARES =				0.000376		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		313.2522	319.6451	326.038		
DISPERSIVITY(cm)		0.118537	0.130261	0.141984		
PULSE WIDTH (cm)		0.01759	0.018323	0.019056		
Co(mV)		6.474319	6.744083	7.013846		
CRITICAL RSS VALUE =			0.000478			

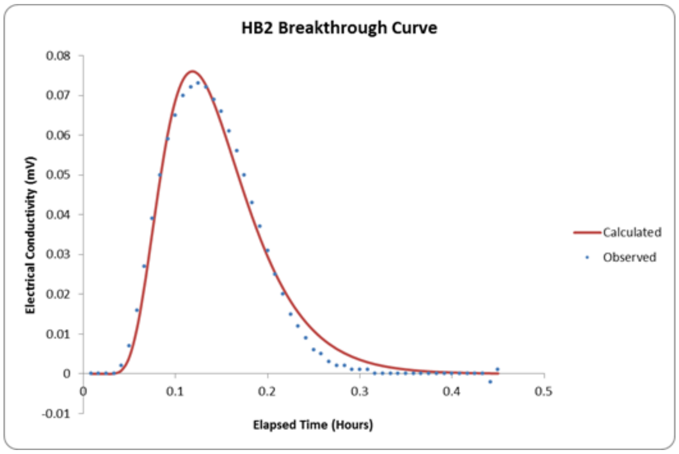
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.115023865	0.130260648	79.883539	49.582886	20.146792	372.7821	319.6451	233.5005	233.5005	0	.	1.394231	0.865385	0.351562	20.14299	233.5005	233.5005
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 04182013_4cm_0845_medsand_30_1gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			369.8363	15.40985		
DISPERSIVITY (cm)			0.113119			
PULSE WIDTH (cm)			0.025515			
RF			1			
Co (mV)			4.280899			
RESDIUAL SUM OF SQUARES =				8.46E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		366.1379	369.8363	373.5346		
DISPERSIVITY(cm)		0.107463	0.113119	0.119906		
PULSE WIDTH (cm)		0.025005	0.025515	0.026026		
Co(mV)		4.195281	4.280899	4.366517		
CRITICAL RSS VALUE =			0.00011			

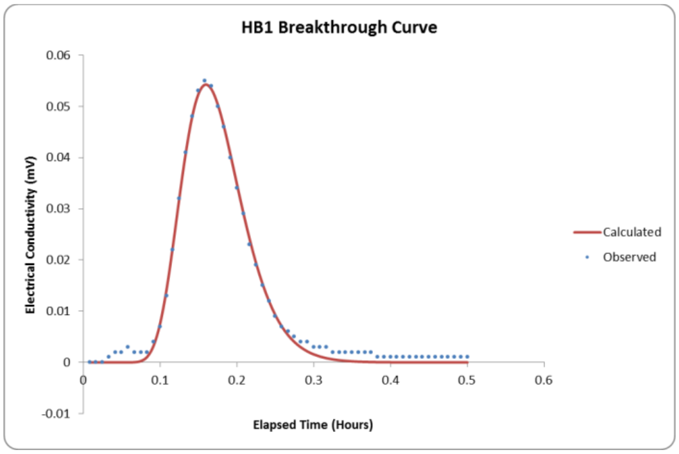
VelProbe output for 04182013_4cm_0845_medsand_30_1gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			315.275	13.13646		
DISPERSIVITY (cm)			0.127277			
PULSE WIDTH (cm)			0.019472			
RF			1			
Co (mV)			6.145203			
RESDIUAL SUM OF SQUARES =				0.000388		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		308.9695	315.275	321.5805		
DISPERSIVITY(cm)		0.115822	0.127277	0.140004		
PULSE WIDTH (cm)		0.018694	0.019472	0.020251		
Co(mV)		5.899394	6.145203	6.391011		
CRITICAL RSS VALUE =			0.000505			

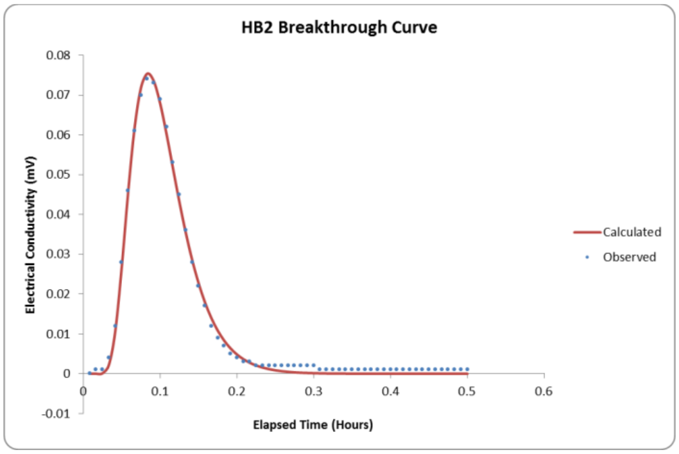
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.11311904	0.127276617	79.883539	49.582886	19.372258	369.8363	315.275	233.4924	233.4924	0	.	1.394231	0.865385	0.338046	19.3686	233.4924	233.4924
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 04182013_4cm_0933_medsand_75_1gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			410.3579	17.09825		
DISPERSIVITY (cm)			0.081646			
PULSE WIDTH (cm)			0.022605			
RF			1			
Co (mV)			4.018326			
RESDIUAL SUM OF SQUARES =				8.46E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.89			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		406.2544	410.3579	414.4615		
DISPERSIVITY(cm)		0.076747	0.081646	0.087361		
PULSE WIDTH (cm)		0.021927	0.022605	0.023057		
Co(mV)		3.897776	4.018326	4.098693		
CRITICAL RSS VALUE =			0.000107			

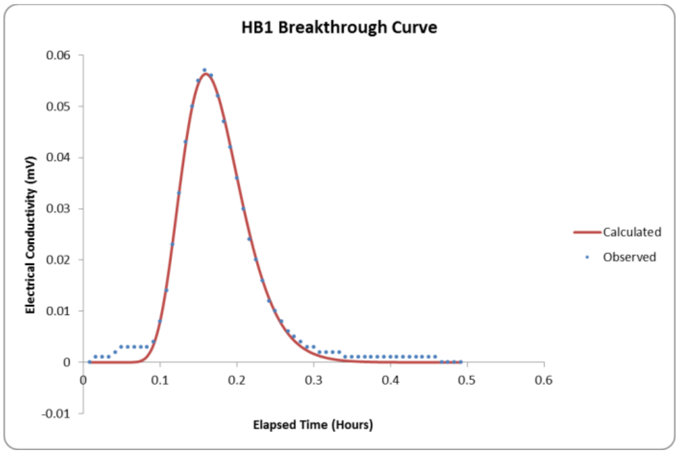
VelProbe output for 04182013_4cm_0933_medsand_75_1gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			445.3322	18.55551		
DISPERSIVITY (cm)			0.122559			
PULSE WIDTH (cm)			0.022167			
RF			1			
Co (mV)			5.265709			
RESDIUAL SUM OF SQUARES =				8E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		440.8788	445.3322	449.7855		
DISPERSIVITY(cm)		0.116431	0.122559	0.128687		
PULSE WIDTH (cm)		0.021723	0.022167	0.02261		
Co(mV)		5.160395	5.265709	5.371023		
CRITICAL RSS VALUE =			0.000101			

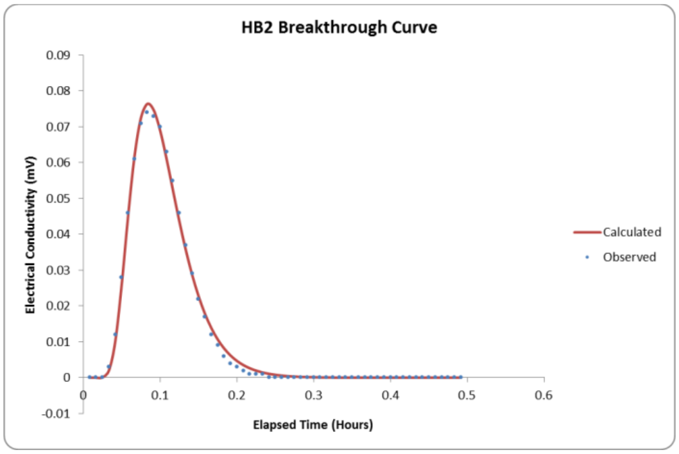
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.122559167	0.081645722	49.582886	79.608078	64.512825	445.3322	410.3579	229.7865	229.7865	-3.092E-15	.	0.865385	1.389423	1.125749	64.50065	229.7865	229.7865
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 04182013_4cm_1008_medsand_75_1gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			411.8202	17.15918		
DISPERSIVITY (cm)			0.082756			
PULSE WIDTH (cm)			0.023791			
RF			1			
Co (mV)			3.993941			
RESDIUAL SUM OF SQUARES =				7.34E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		411.8202	411.8202	411.8202		
DISPERSIVITY(cm)		0.077791	0.082756	0.087721		
PULSE WIDTH (cm)		0.023315	0.023791	0.024267		
Co(mV)		3.914062	3.993941	4.07382		
CRITICAL RSS VALUE =			9.34E-05			

VelProbe output for 04182013_4cm_1008_medsand_75_1gL_0.1 – Half Bridge 2

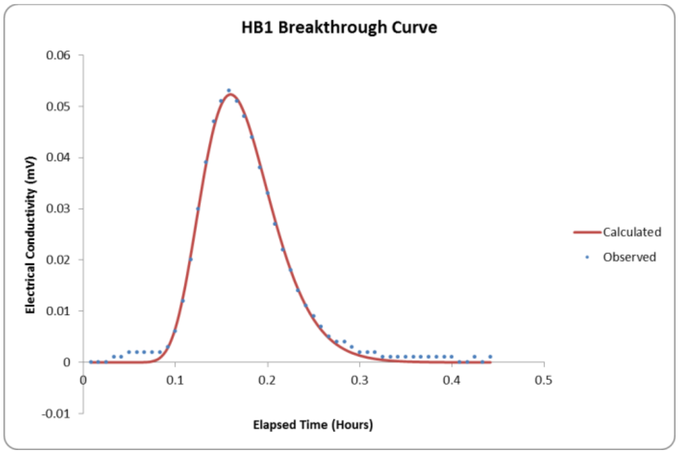


OPTIMIZED PARAMETER ESTIMATES				
		cm/hr		
VELOCITY(cm/d)	445.2712	18.55297		
DISPERSIVITY (cm)	0.11956			
PULSE WIDTH (cm)	0.022059			
RF	1			
Co (mV)	5.30508			
RESDIUAL SUM OF SQUARES =		6.8E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS				
				FIX
VELOCITY(cm/d)	200			
DISPERSIVITY (cm)	0.1			
PULSE WIDTH (cm)	0.01			
RF	1			Y
Co (mV)	2			
DISTANCE FROM SOURCE (cm)	1.8			Y
DIFFUSION COEFF (cm^2/sec)	0.000001			Y

95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS			
Parameter	Low	Optimized	High
VELOCITY(cm/d)	440.8185	445.2712	449.7239
DISPERSIVITY(cm)	0.114778	0.11956	0.124343
PULSE WIDTH (cm)	0.021618	0.022059	0.0225
Co(mV)	5.198978	5.30508	5.411181
CRITICAL RSS VALUE =		8.65E-05	

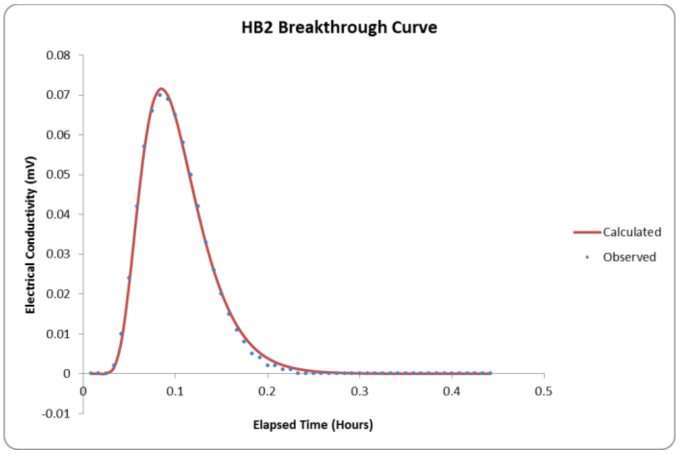
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.082755921	0.119560223	79.883539	49.582886	63.47308	411.8202	445.2712	229.8443	229.8443	-3.091E-15	.	1.394231	0.865385	1.107605	63.46111	229.8443	229.8443
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 04182013_4cm_1103_medsand_75_1gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			412.255	17.17729		
DISPERSIVITY (cm)			0.078992			
PULSE WIDTH (cm)			0.023074			
RF			1			
Co (mV)			3.740148			
RESDIUAL SUM OF SQUARES =				4.2E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		412.255	412.255	412.255		
DISPERSIVITY(cm)		0.075042	0.078992	0.082941		
PULSE WIDTH (cm)		0.022613	0.023074	0.023536		
Co(mV)		3.665346	3.740148	3.814951		
CRITICAL RSS VALUE =			5.49E-05			

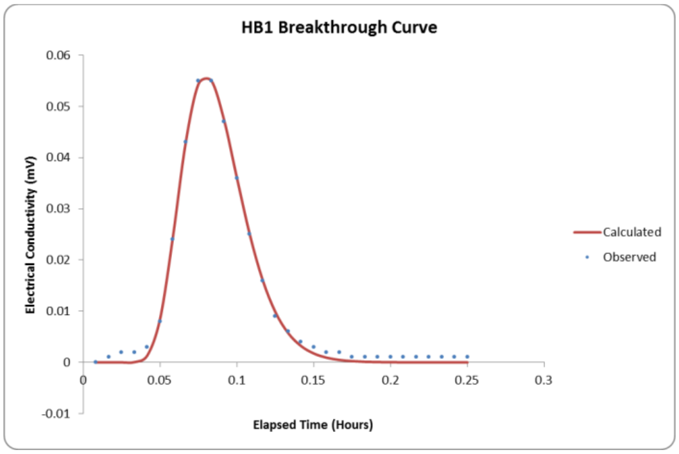
VelProbe output for 04182013_4cm_1103_medsand_75_1gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			447.3412	18.63922		
DISPERSIVITY (cm)			0.114313			
PULSE WIDTH (cm)			0.020716			
RF			1			
Co (mV)			5.190541			
RESDIUAL SUM OF SQUARES =				3.53E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		447.3412	447.3412	447.3412		
DISPERSIVITY(cm)		0.110884	0.114313	0.118886		
PULSE WIDTH (cm)		0.020509	0.020716	0.020923		
Co(mV)		5.138635	5.190541	5.242446		
CRITICAL RSS VALUE =			4.62E-05			

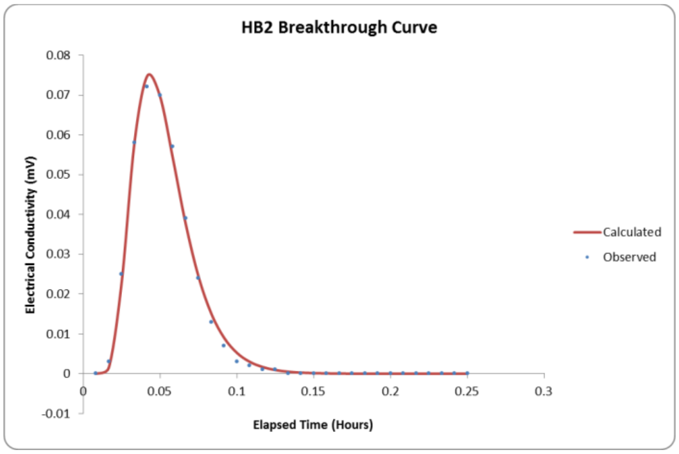
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.078991511	0.114313295	79.883539	49.582886	64.235863	412.255	447.3412	230.8396	230.8396	-6.156E-15	.	1.394231	0.865385	1.120916	64.22375	230.8396	230.8396
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 04182013_4cm_1422_medsand_75_1gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			824.3687	34.3487		
DISPERSIVITY (cm)			0.084758			
PULSE WIDTH (cm)			0.023789			
RF			1			
Co (mV)			4.016647			
RESDIUAL SUM OF SQUARES =				2.81E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		816.125	824.3687	832.6124		
DISPERSIVITY(cm)		0.078825	0.084758	0.091539		
PULSE WIDTH (cm)		0.023075	0.023789	0.024502		
Co(mV)		3.896147	4.016647	4.137146		
CRITICAL RSS VALUE =			4.47E-05			

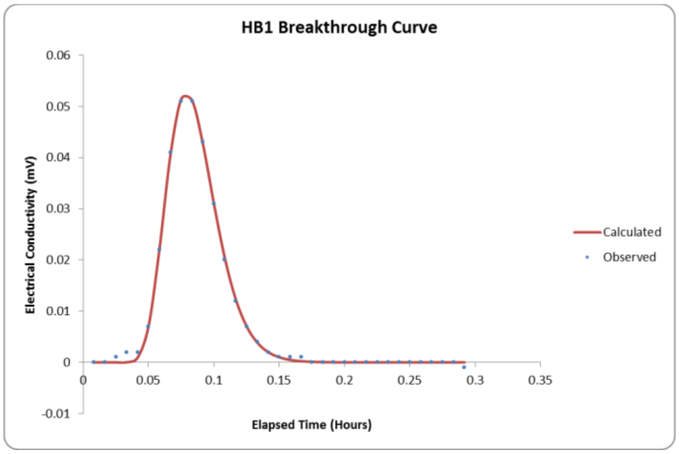
VelProbe output for 04182013_4cm_1422_medsand_75_1gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			871.6821	36.32009		
DISPERSIVITY (cm)			0.118747			
PULSE WIDTH (cm)			0.019853			
RF			1			
Co (mV)			5.783593			
RESDIUAL SUM OF SQUARES =				4.02E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		862.9653	871.6821	880.3989		
DISPERSIVITY(cm)		0.110435	0.118747	0.128247		
PULSE WIDTH (cm)		0.019258	0.019853	0.020449		
Co(mV)		5.610085	5.783593	5.9571		
CRITICAL RSS VALUE =			6.39E-05			

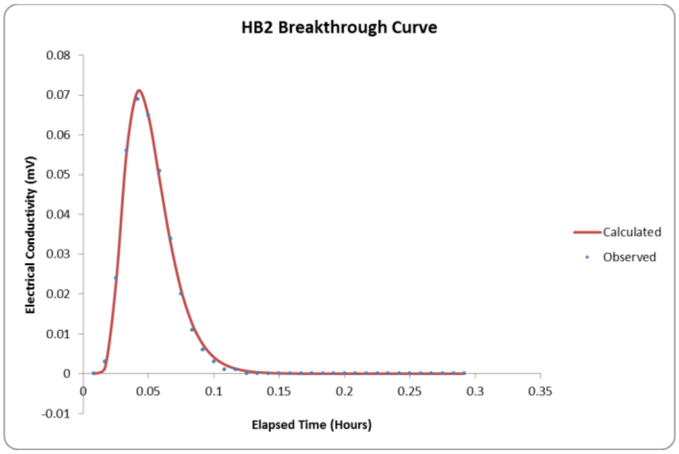
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.084758151	0.118746806	79.883539	49.582886	58.691006	824.3687	871.6821	452.6795	452.6795	0	.	1.394231	0.865385	1.024158	58.67993	452.6795	452.6795
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 04182013_4cm_1437_medsand_75_1gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES					
			cm/hr		
VELOCITY(cm/d)		837.2668	34.88612		
DISPERSIVITY (cm)		0.076535			
PULSE WIDTH (cm)		0.022085			
RF		1			
Co (mV)		3.872043			
RESDIUAL SUM OF SQUARES =			8.98E-06		
INITIAL GUESSES AND INPUT OF PARAMETERS					
					FIX
VELOCITY(cm/d)		400			
DISPERSIVITY (cm)		0.1			
PULSE WIDTH (cm)		0.01			
RF		1			Y
Co (mV)		2			
DISTANCE FROM SOURCE (cm)		2.9			Y
DIFFUSION COEFF (cm^2/sec)		0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS					
Parameter	Low	Optimized	High		
VELOCITY(cm/d)	837.2668	837.2668	837.2668		
DISPERSIVITY(cm)	0.073474	0.076535	0.079597		
PULSE WIDTH (cm)	0.021643	0.022085	0.022526		
Co(mV)	3.794602	3.872043	3.949484		
CRITICAL RSS VALUE =		1.34E-05			

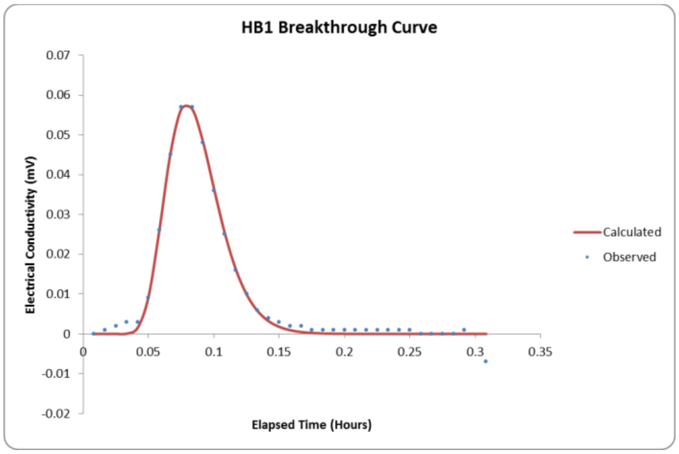
VelProbe output for 04182013_4cm_1437_medsand_75_1gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			888.6866	37.02861		
DISPERSIVITY (cm)			0.115514			
PULSE WIDTH (cm)			0.020615			
RF			1			
Co (mV)			5.201296			
RESDIUAL SUM OF SQUARES =				2.24E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		879.7998	888.6866	897.5735		
DISPERSIVITY(cm)		0.109738	0.115514	0.122444		
PULSE WIDTH (cm)		0.020203	0.020615	0.021028		
Co(mV)		5.09727	5.201296	5.305322		
CRITICAL RSS VALUE =			3.34E-05			

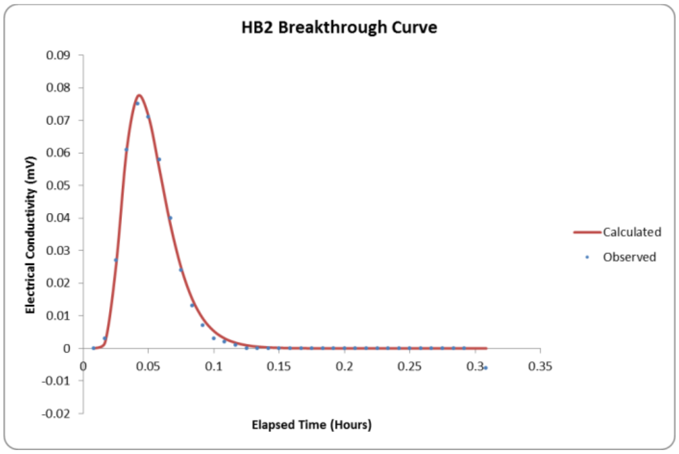
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.076535447	0.115513532	79.883539	49.582886	59.508123	837.2668	888.6866	460.8052	460.8052	0	.	1.394231	0.865385	1.038417	59.4969	460.8052	460.8052
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 04182013_4cm_1508_medsand_75_1gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			828.7694	34.53206		
DISPERSIVITY (cm)			0.085906			
PULSE WIDTH (cm)			0.024342			
RF			1			
Co (mV)			4.070651			
RESDIUAL SUM OF SQUARES =				8.18E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		820.4817	828.7694	837.0571		
DISPERSIVITY(cm)		0.076457	0.085906	0.097074		
PULSE WIDTH (cm)		0.023125	0.024342	0.025559		
Co(mV)		3.867118	4.070651	4.274183		
CRITICAL RSS VALUE =			0.000121			

VelProbe output for 04182013_4cm_1508_medsand_75_1gL_0.1 – Half Bridge 2



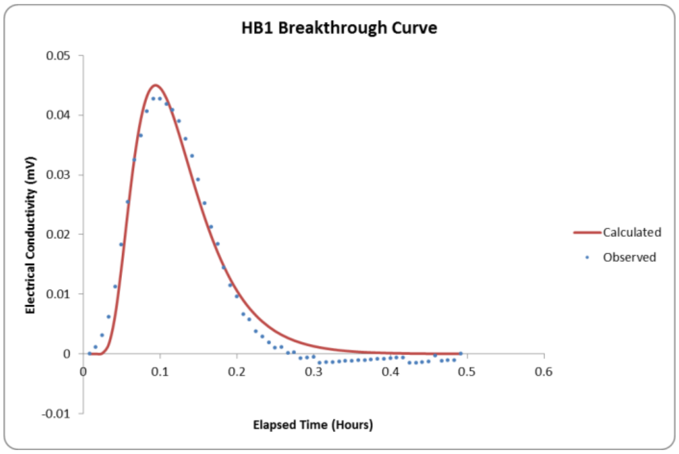
OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			878.5594	36.60664		
DISPERSIVITY (cm)			0.120484			
PULSE WIDTH (cm)			0.02488			
RF			1			
Co (mV)			4.789667			
RESDIUAL SUM OF SQUARES =				7.81E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		860.9882	878.5594	896.1306		
DISPERSIVITY(cm)		0.109641	0.120484	0.131328		
PULSE WIDTH (cm)		0.023884	0.02488	0.025875		
Co(mV)		4.598081	4.789667	4.981254		
CRITICAL RSS VALUE =			0.000115			

Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.085906239	0.120484265	79.883539	49.582886	59.236803	828.7694	878.5594	455.7749	455.7749	3.118E-15	.	1.394231	0.865385	1.033682	59.22563	455.7749	455.7749
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VELPROBE OUTPUT

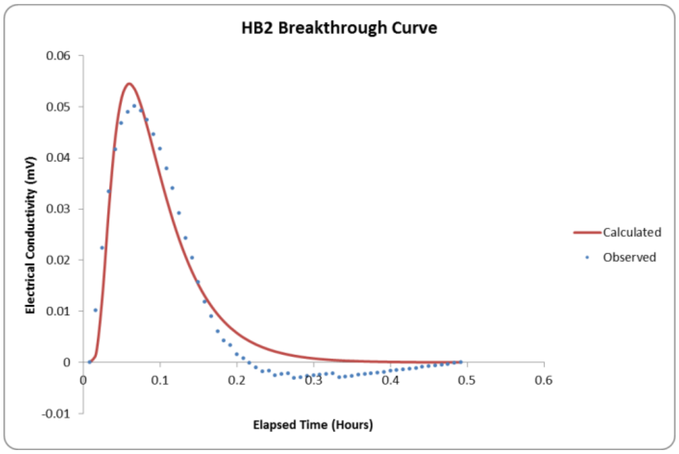
2 cm PVP Data for Medium Sand

VelProbe output for 05202013_2cm_1342_medsand_45_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			290.6087	12.10869		
DISPERSIVITY (cm)			0.133018			
PULSE WIDTH (cm)			0.017314			
RF			1			
Co (mV)			3.583281			
RESDIUAL SUM OF SQUARES =				0.000257		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		281.8904	290.6087	299.3269		
DISPERSIVITY(cm)		0.115726	0.133018	0.152971		
PULSE WIDTH (cm)		0.016275	0.017314	0.01818		
Co(mV)		3.368285	3.583281	3.762445		
CRITICAL RSS VALUE =			0.000327			

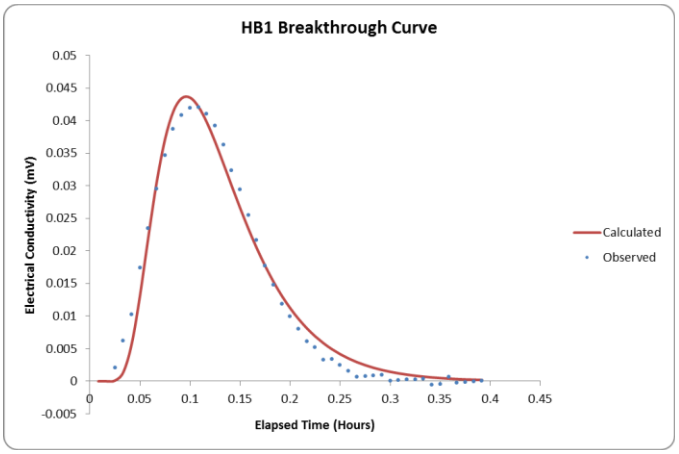
VelProbe output for 05202013_2cm_1342_medsand_45_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			257.1701	10.71542		
DISPERSIVITY (cm)			0.140539			
PULSE WIDTH (cm)			0.009183			
RF			1			
Co (mV)			6.282423			
RESDIUAL SUM OF SQUARES =				0.000762		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		241.7399	257.1701	275.172		
DISPERSIVITY(cm)		0.113837	0.140539	0.174268		
PULSE WIDTH (cm)		0.008356	0.009183	0.010009		
Co(mV)		5.717005	6.282423	6.847842		
CRITICAL RSS VALUE =			0.00097			

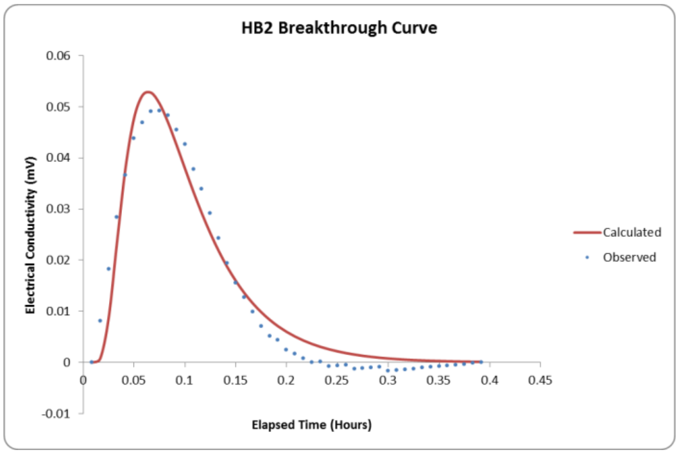
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.133018194	0.140538999	83.832772	53.918344	21.8112	290.6087	257.1701	177.4607	177.4607	-4.004E-15	.	1.463158	0.941053	0.380605	21.80709	177.4607	177.4607
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05202013_2cm_1414_medsand_45_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			284.2736	11.84473		
DISPERSIVITY (cm)			0.133039			
PULSE WIDTH (cm)			0.017288			
RF			1			
Co (mV)			3.478765			
RESDIUAL SUM OF SQUARES =				0.000172		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		275.7454	284.2736	292.8018		
DISPERSIVITY(cm)		0.117074	0.133039	0.151664		
PULSE WIDTH (cm)		0.016424	0.017288	0.018153		
Co(mV)		3.304827	3.478765	3.652703		
CRITICAL RSS VALUE =			0.000232			

VelProbe output for 05202013_2cm_1414_medsand_45_0.5gL_0.1 – Half Bridge 2

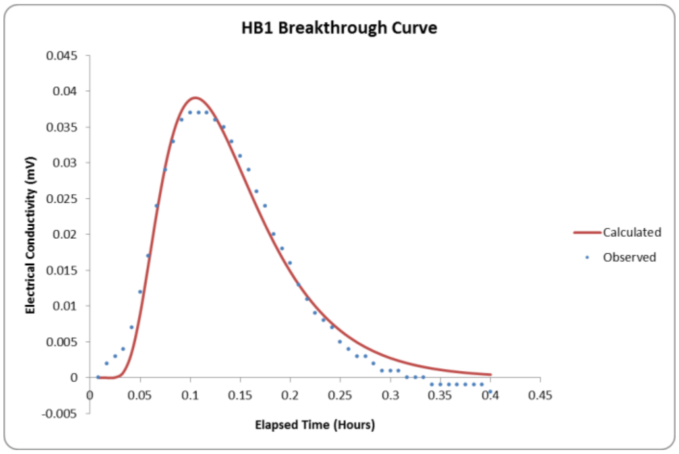


OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			245.7001	10.23751		
DISPERSIVITY (cm)			0.130361			
PULSE WIDTH (cm)			0.017022			
RF			1			
Co (mV)			3.184829			
RESDIUAL SUM OF SQUARES =				0.000486		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.89			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		233.4151	245.7001	260.4422		
DISPERSIVITY(cm)		0.106896	0.130361	0.160345		
PULSE WIDTH (cm)		0.01566	0.017022	0.018384		
Co(mV)		2.930042	3.184829	3.439615		
CRITICAL RSS VALUE =			0.000656			

Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.133038719	0.130361469	83.832772	53.677099	18.665451	284.2736	245.7001	178.7021	178.7021	0	.	1.463158	0.936842	0.325712	18.66193	178.7021	178.7021
Probe 2	0.133038719	0.130361469	79.641134	50.993244	19.702682	284.2736	245.7001	178.9956	178.9956	3.97E-15							
Probe 3	0.133038719	0.130361469	75.848699	48.564994	20.552218	284.2736	245.7001	179.5792	179.5792	0							
Probe 4	0.133038719	0.130361469	72.40103	46.357494	21.243447	284.2736	245.7001	180.4084	180.4084	3.939E-15							
Probe 5	0.133038719	0.130361469	88.490148	56.65916	17.404493	284.2736	245.7001	178.7571	178.7571	3.975E-15							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

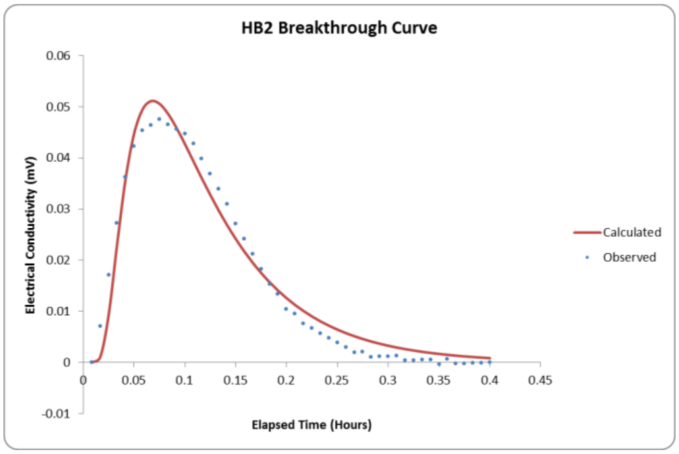
diameter	1.9
	2
	2.1
	2.2
	1.8

VelProbe output for 05202013_2cm_1438_medsand_45_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			256.1219	10.67175		
DISPERSIVITY (cm)			0.142802			
PULSE WIDTH (cm)			0.017608			
RF			1			
Co (mV)			3.140072			
RESDIUAL SUM OF SQUARES =				0.000152		
INITIAL GUESSES AND INPUT OF PARAMETERS						
					FIX	
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1		Y	
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39		Y	
DIFFUSION COEFF (cm^2/sec)			0.000001		Y	
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		248.4382	256.1219	263.8056		
DISPERSIVITY(cm)		0.125665	0.142802	0.161366		
PULSE WIDTH (cm)		0.016727	0.017608	0.018488		
Co(mV)		2.983069	3.140072	3.297076		
CRITICAL RSS VALUE =			0.000205			

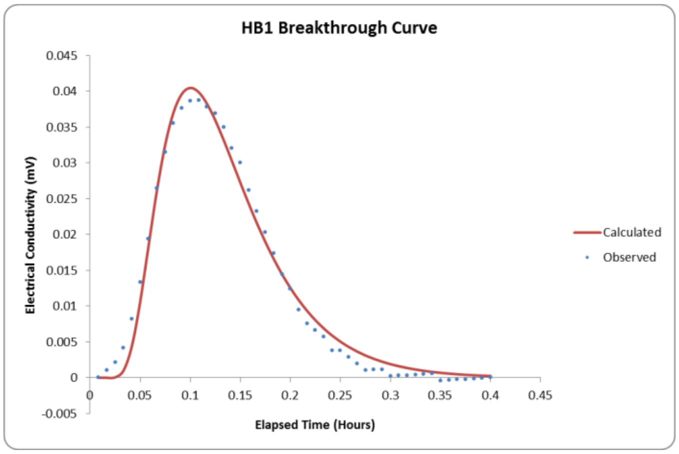
VelProbe output for 05202013_2cm_1438_medsand_45_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			207.1527	8.631363		
DISPERSIVITY (cm)			0.173075			
PULSE WIDTH (cm)			0.016998			
RF			1			
Co (mV)			3.376814			
RESDIUAL SUM OF SQUARES =				0.000382		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		196.7951	207.1527	219.5819		
DISPERSIVITY(cm)		0.148844	0.173075	0.204228		
PULSE WIDTH (cm)		0.015808	0.016998	0.018188		
Co(mV)		3.174205	3.376814	3.613191		
CRITICAL RSS VALUE =			0.000513			

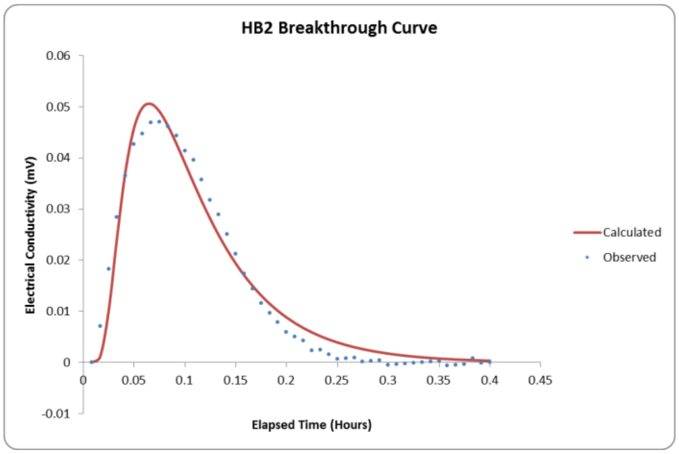
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.142801638	0.173074655	83.832772	53.918344	10.371644	256.1219	207.1527	177.2778	177.2778	-4.008E-15	.	1.463158	0.941053	0.180985	10.36969	177.2778	177.2778
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05202013_2cm_1504_medsand_45_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			270.8857	11.2869		
DISPERSIVITY (cm)			0.136417			
PULSE WIDTH (cm)			0.015941			
RF			1			
Co (mV)			3.532864			
RESDIUAL SUM OF SQUARES =				0.00011		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		265.468	270.8857	276.3034		
DISPERSIVITY(cm)		0.122775	0.136417	0.151423		
PULSE WIDTH (cm)		0.015303	0.015941	0.016579		
Co(mV)		3.391549	3.532864	3.674178		
CRITICAL RSS VALUE =			0.000148			

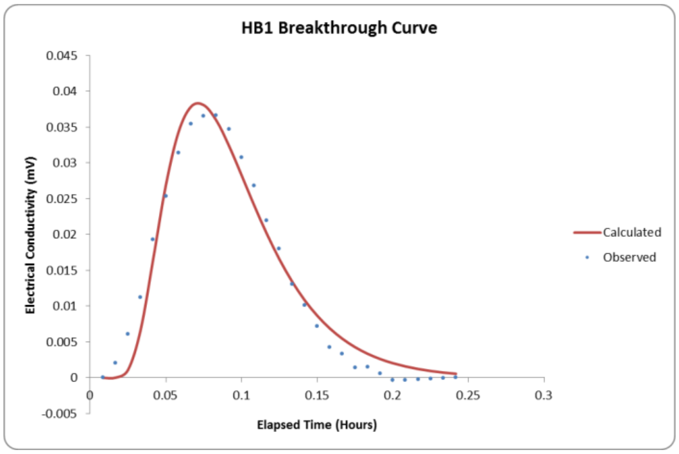
VelProbe output for 05202013_2cm_1504_medsand_45_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			229.0984	9.545768		
DISPERSIVITY (cm)			0.155615			
PULSE WIDTH (cm)			0.014617			
RF			1			
Co (mV)			3.775014			
RESDIUAL SUM OF SQUARES =				0.000374		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		217.6435	229.0984	242.8443		
DISPERSIVITY(cm)		0.132273	0.155615	0.185182		
PULSE WIDTH (cm)		0.013594	0.014617	0.01564		
Co(mV)		3.510763	3.775014	4.039265		
CRITICAL RSS VALUE =			0.000502			

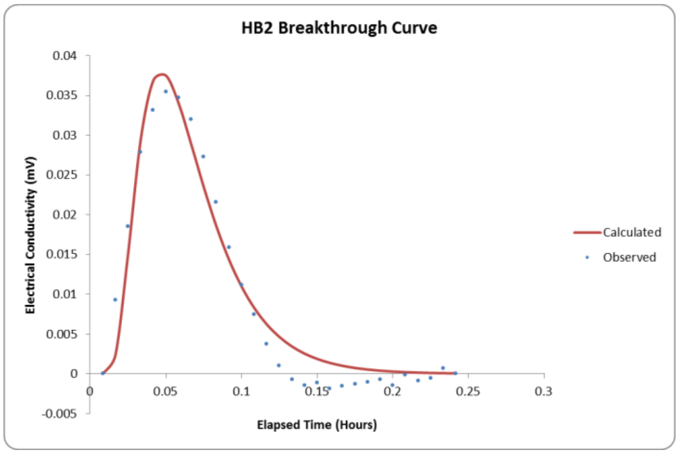
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.136416678	0.15561541	83.832772	53.918344	15.56267	270.8857	229.0984	175.9128	175.9128	-8.078E-15	.	1.463158	0.941053	0.271569	15.55973	175.9128	175.9128
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05202013_2cm_1547_medsand_75_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			386.7632	16.11513		
DISPERSIVITY (cm)			0.12554			
PULSE WIDTH (cm)			0.017533			
RF			1			
Co (mV)			2.939111			
RESDIUAL SUM OF SQUARES =				0.000144		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		367.425	386.7632	406.1014		
DISPERSIVITY(cm)		0.101687	0.12554	0.15818		
PULSE WIDTH (cm)		0.015955	0.017533	0.019111		
Co(mV)		2.674591	2.939111	3.203631		
CRITICAL RSS VALUE =			0.000232			

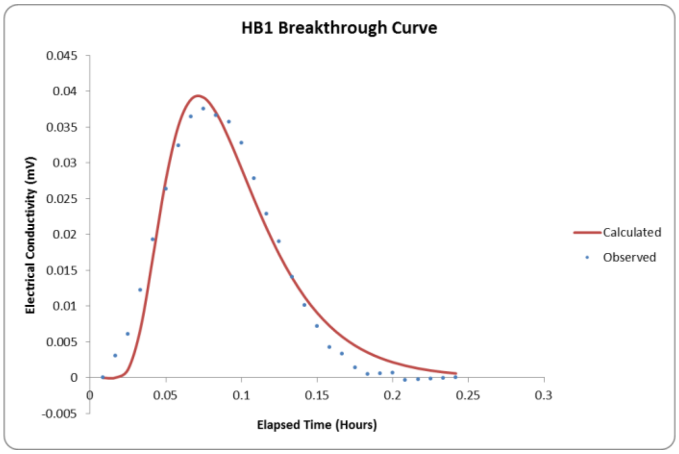
VelProbe output for 05202013_2cm_1547_medsand_75_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			363.3345	15.13894		
DISPERSIVITY (cm)			0.100214			
PULSE WIDTH (cm)			0.012369			
RF			1			
Co (mV)			2.88744			
RESDIUAL SUM OF SQUARES =				0.000209		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		334.2677	363.3345	396.0346		
DISPERSIVITY(cm)		0.074158	0.100214	0.139298		
PULSE WIDTH (cm)		0.010761	0.012369	0.013976		
Co(mV)		2.512072	2.88744	3.262807		
CRITICAL RSS VALUE =			0.000337			

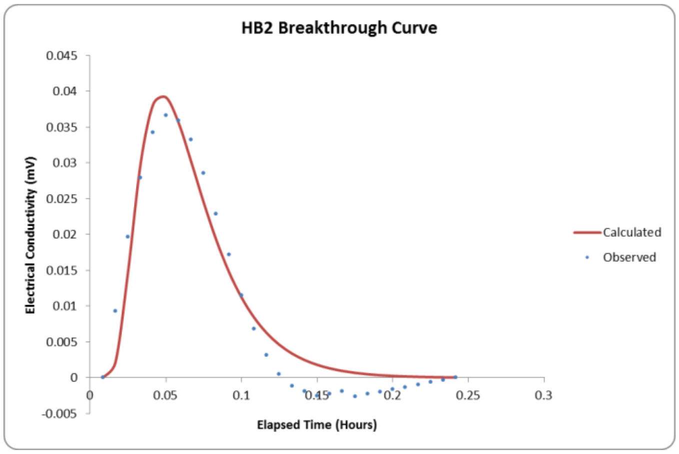
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.125540014	0.100214147	83.832772	53.918344	31.725169	386.7632	363.3345	220.7142	220.7142	-6.439E-15	.	1.463158	0.941053	0.553604	31.71918	220.7142	220.7142
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05202013_2cm_1606_medsand_75_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			386.2497	16.09374		
DISPERSIVITY (cm)			0.126898			
PULSE WIDTH (cm)			0.015984			
RF			1			
Co (mV)			3.326107			
RESDIUAL SUM OF SQUARES =				0.000172		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		366.9373	386.2497	409.4247		
DISPERSIVITY(cm)		0.10025	0.126898	0.161161		
PULSE WIDTH (cm)		0.014545	0.015984	0.017582		
Co(mV)		3.026757	3.326107	3.658717		
CRITICAL RSS VALUE =			0.000278			

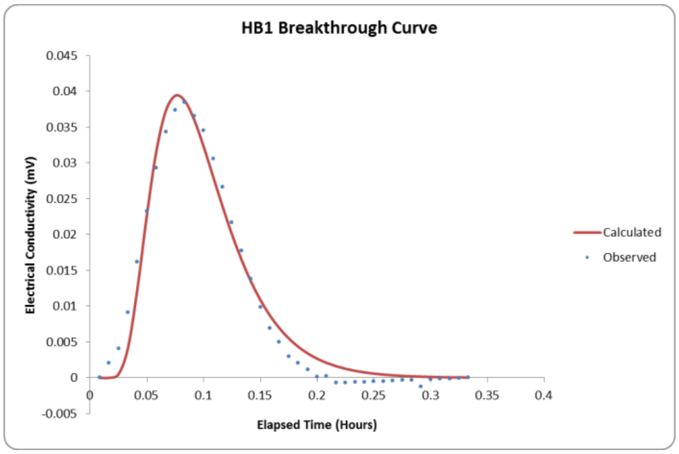
VelProbe output for 05202013_2cm_1606_medsand_75_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			363.0504	15.1271		
DISPERSIVITY (cm)			0.097795			
PULSE WIDTH (cm)			0.010599			
RF			1			
Co (mV)			3.472724			
RESDIUAL SUM OF SQUARES =				0.000286		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		334.0064	363.0504	399.3555		
DISPERSIVITY(cm)		0.069435	0.097795	0.140825		
PULSE WIDTH (cm)		0.009009	0.010599	0.012083		
Co(mV)		2.951815	3.472724	3.958905		
CRITICAL RSS VALUE =			0.000461			

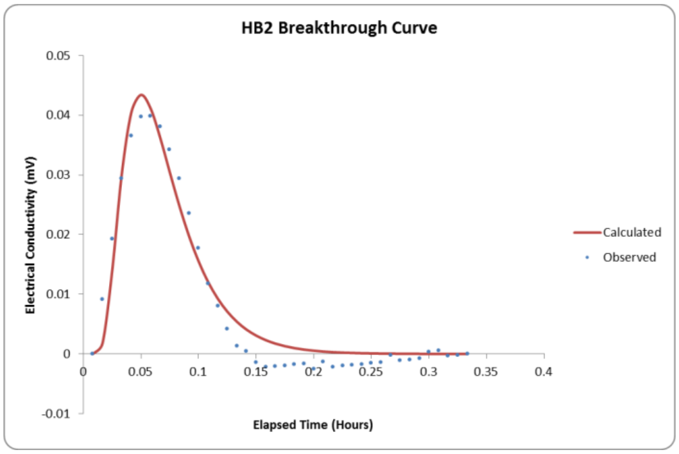
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.126898255	0.097795137	83.832772	53.918344	31.824681	386.2497	363.0504	220.3092	220.3092	0	.	1.463158	0.941053	0.555341	31.81868	220.3092	220.3092
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05202013_2cm_1624_medsand_75_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			364.3554	15.18147		
DISPERSIVITY (cm)			0.118069			
PULSE WIDTH (cm)			0.011952			
RF			1			
Co (mV)			4.337045			
RESDIUAL SUM OF SQUARES =				0.000151		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		349.7811	364.3554	378.9296		
DISPERSIVITY(cm)		0.100359	0.118069	0.141683		
PULSE WIDTH (cm)		0.011115	0.011952	0.012789		
Co(mV)		4.033451	4.337045	4.640638		
CRITICAL RSS VALUE =			0.000215			

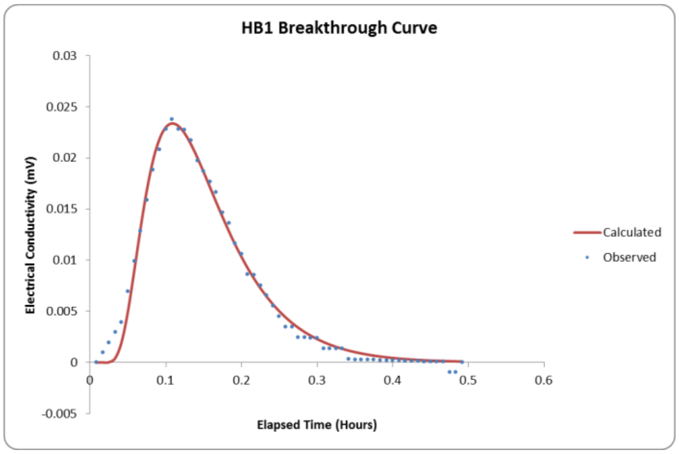
VelProbe output for 05202013_2cm_1624_medsand_75_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			337.6864	14.07027		
DISPERSIVITY (cm)			0.10099			
PULSE WIDTH (cm)			0.012973			
RF			1			
Co (mV)			3.14448			
RESDIUAL SUM OF SQUARES =				0.000328		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.89			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		314.0484	337.6864	361.3245		
DISPERSIVITY(cm)		0.077762	0.10099	0.134317		
PULSE WIDTH (cm)		0.011546	0.012973	0.0144		
Co(mV)		2.798587	3.14448	3.490373		
CRITICAL RSS VALUE =			0.000467			

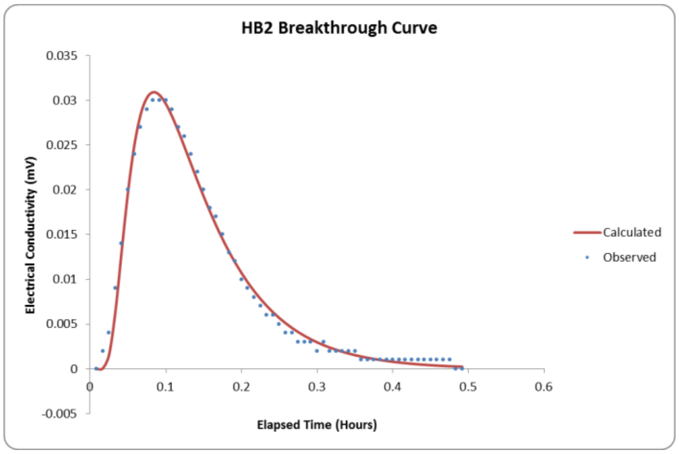
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.118068993	0.100990004	83.832772	53.677099	29.498739	364.3554	337.6864	210.4863	210.4863	0	.	1.463158	0.936842	0.514753	29.49317	210.4863	210.4863
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05212013_2cm_1231_medsand_30_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			244.3511	10.18129		
DISPERSIVITY (cm)			0.150737			
PULSE WIDTH (cm)			0.013438			
RF			1			
Co (mV)			2.513972			
RESDIUAL SUM OF SQUARES =				3.36E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		239.464	244.3511	249.2381		
DISPERSIVITY(cm)		0.138678	0.150737	0.164303		
PULSE WIDTH (cm)		0.013035	0.013438	0.013841		
Co(mV)		2.438553	2.513972	2.589391		
CRITICAL RSS VALUE =			4.28E-05			

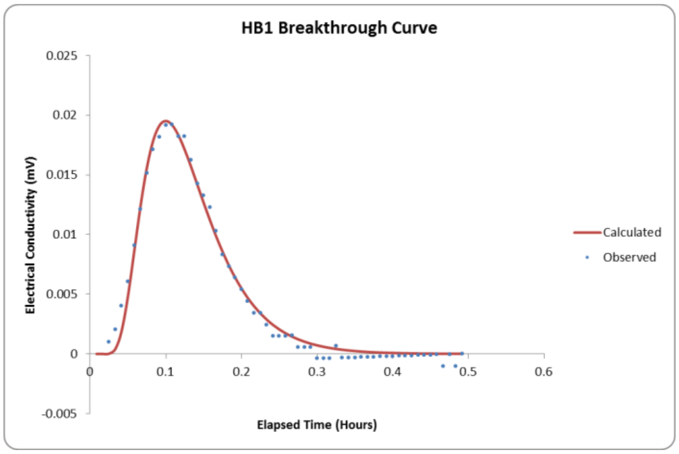
VelProbe output for 05212013_2cm_1231_medsand_30_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES					
			cm/hr		
VELOCITY(cm/d)		178.6044	7.441851		
DISPERSIVITY (cm)		0.148752			
PULSE WIDTH (cm)		0.013574			
RF		1			
Co (mV)		2.450441			
RESDIUAL SUM OF SQUARES =			4.12E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS					
					FIX
VELOCITY(cm/d)		200			
DISPERSIVITY (cm)		0.1			
PULSE WIDTH (cm)		0.01			
RF		1			Y
Co (mV)		2			
DISTANCE FROM SOURCE (cm)		0.894			Y
DIFFUSION COEFF (cm^2/sec)		0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS					
Parameter	Low	Optimized	High		
VELOCITY(cm/d)	175.0323	178.6044	182.1765		
DISPERSIVITY(cm)	0.139827	0.148752	0.159164		
PULSE WIDTH (cm)	0.013167	0.013574	0.013981		
Co(mV)	2.376928	2.450441	2.523954		
CRITICAL RSS VALUE =		5.25E-05			

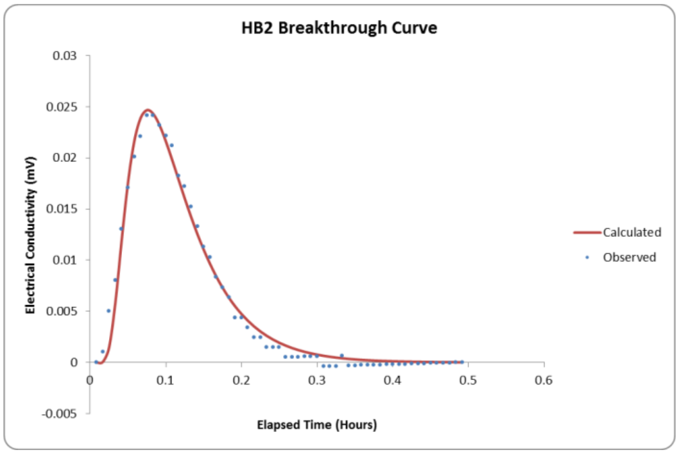
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.150736605	0.148751717	83.832772	53.918344	1.4365408	244.3511	178.6044	194.8979	194.8979	-3.646E-15	.	1.463158	0.941053	0.025068	1.43627	194.8979	194.8979
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05212013_2cm_1308_medsand_30_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			275.6744	11.48643		
DISPERSIVITY (cm)			0.128494			
PULSE WIDTH (cm)			0.010139			
RF			1			
Co (mV)			2.611113			
RESDIUAL SUM OF SQUARES =				2.52E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		270.1609	275.6744	281.1878		
DISPERSIVITY(cm)		0.11693	0.128494	0.141344		
PULSE WIDTH (cm)		0.009733	0.010139	0.010544		
Co(mV)		2.506669	2.611113	2.715558		
CRITICAL RSS VALUE =			3.21E-05			

VelProbe output for 05212013_2cm_1308_medsand_30_0.5gL_0.1 – Half Bridge 2

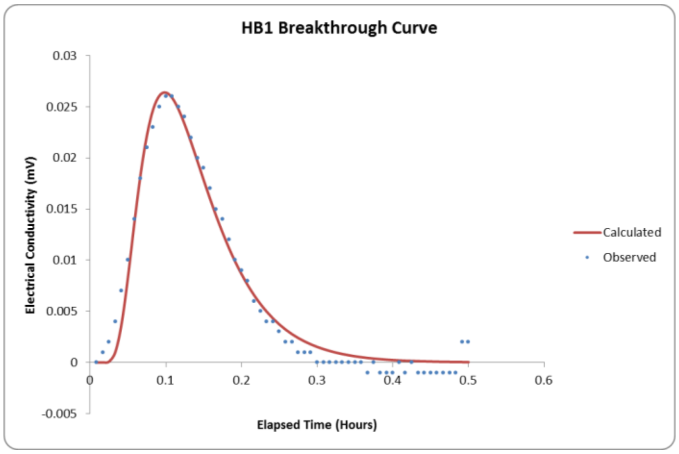


OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			211.8162	8.825674		
DISPERSIVITY (cm)			0.121658			
PULSE WIDTH (cm)			0.010864			
RF			1			
Co (mV)			2.289774			
RESDIUAL SUM OF SQUARES =				4.45E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		205.4617	211.8162	218.1707		
DISPERSIVITY(cm)		0.109492	0.121658	0.13504		
PULSE WIDTH (cm)		0.01043	0.010864	0.011299		
Co(mV)		2.198183	2.289774	2.381365		
CRITICAL RSS VALUE =			5.66E-05			

Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.121658003	0.128494446	53.918344	83.832772	5.4146297	211.8162	275.6744	205.2934	205.2934	-3.461E-15	.	0.941053	1.463158	0.094485	5.413608	205.2934	205.2934
Probe 2	0.108736156	0.118434115	53.918344	83.832772	14.488586	256.5953	306.0277	201.1735	201.1735	-3.532E-15							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

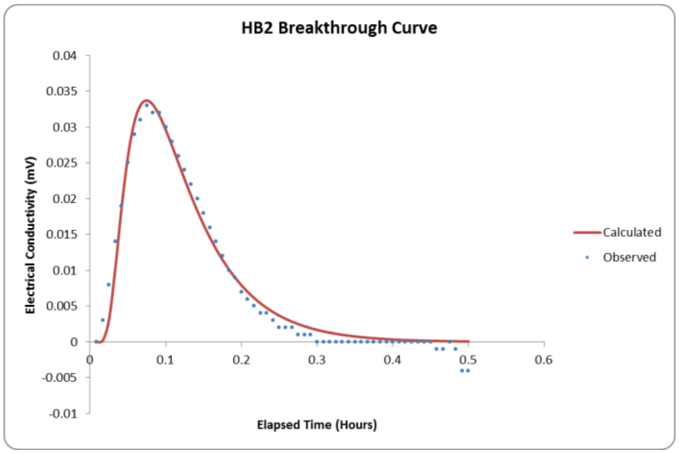
results for HB1 and HB2
results for HB3 and HB4

VelProbe output for 05212013_2cm_1341_medsand_30_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			270.25	11.26042		
DISPERSIVITY (cm)			0.149638			
PULSE WIDTH (cm)			0.012569			
RF			1			
Co (mV)			3.02445			
RESDIUAL SUM OF SQUARES =				7.92E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		262.1425	270.25	278.3575		
DISPERSIVITY(cm)		0.133178	0.149638	0.169091		
PULSE WIDTH (cm)		0.01194	0.012569	0.013197		
Co(mV)		2.873228	3.02445	3.175673		
CRITICAL RSS VALUE =			0.0001			

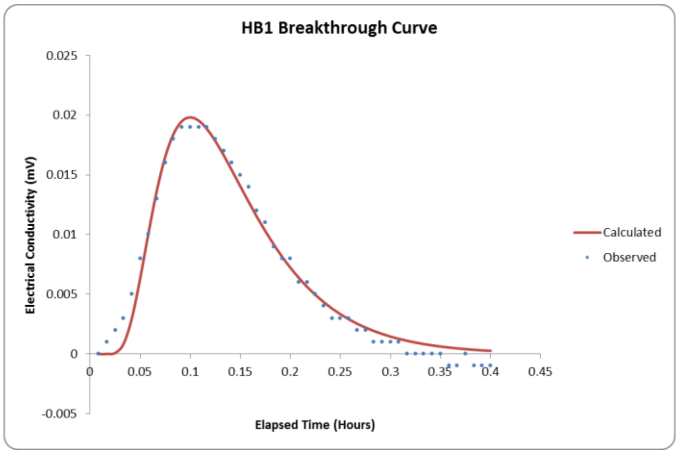
VelProbe output for 05212013_2cm_1341_medsand_30_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			205.4509	8.560453		
DISPERSIVITY (cm)			0.142735			
PULSE WIDTH (cm)			0.011554			
RF			1			
Co (mV)			3.105579			
RESDIUAL SUM OF SQUARES =				0.000135		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		197.2328	205.4509	213.6689		
DISPERSIVITY(cm)		0.125607	0.142735	0.162718		
PULSE WIDTH (cm)		0.010976	0.011554	0.012132		
Co(mV)		2.9503	3.105579	3.260858		
CRITICAL RSS VALUE =			0.000171			

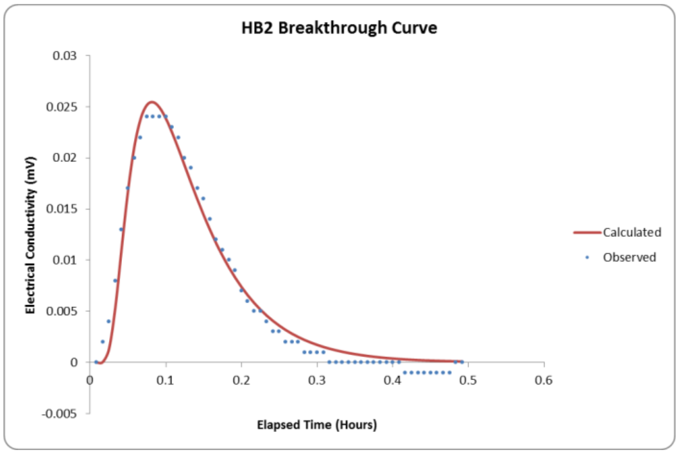
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.149638228	0.142735301	83.832772	53.918344	4.5032363	270.25	205.4509	204.2743	204.2743	-6.957E-15	.	1.463158	0.941053	0.078581	4.502387	204.2743	204.2743
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05212013_2cm_1425_medsand_15_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			262.6679	10.9445		
DISPERSIVITY (cm)			0.159342			
PULSE WIDTH (cm)			0.009166			
RF			1			
Co (mV)			3.193504			
RESDIUAL SUM OF SQUARES =				3.94E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		254.7879	262.6679	270.548		
DISPERSIVITY(cm)		0.140221	0.159342	0.180057		
PULSE WIDTH (cm)		0.008707	0.009166	0.009624		
Co(mV)		3.033829	3.193504	3.353179		
CRITICAL RSS VALUE =			5.29E-05			

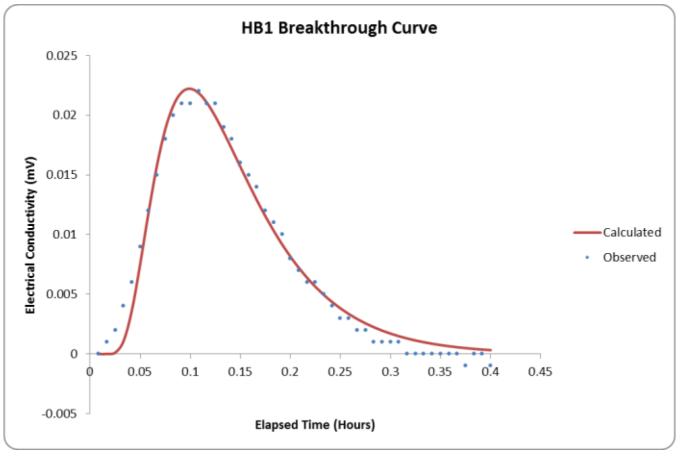
VelProbe output for 05212013_2cm_1425_medsand_15_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			189.5653	7.898556		
DISPERSIVITY (cm)			0.137829			
PULSE WIDTH (cm)			0.011385			
RF			1			
Co (mV)			2.346532			
RESDIUAL SUM OF SQUARES =				6.75E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		183.8784	189.5653	195.2523		
DISPERSIVITY(cm)		0.122668	0.137829	0.154368		
PULSE WIDTH (cm)		0.010815	0.011385	0.011954		
Co(mV)		2.229205	2.346532	2.463858		
CRITICAL RSS VALUE =			8.59E-05			

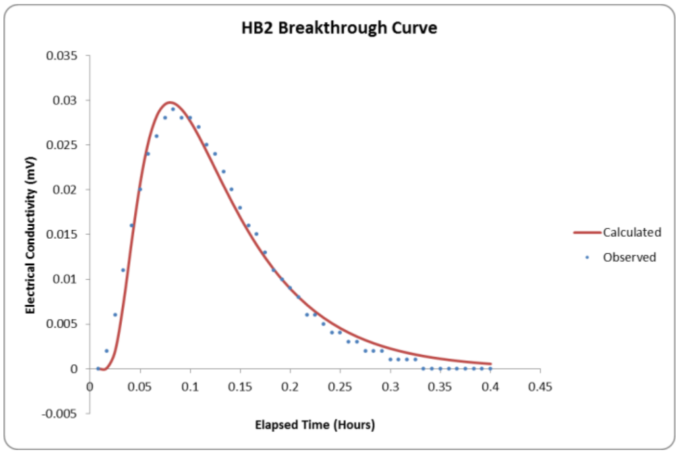
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.159342488	0.137828801	83.832772	53.918344	0.5353921	262.6679	189.5653	213.0831	213.0831	-6.669E-15	.	1.463158	0.941053	0.009343	0.535291	213.0831	213.0831
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05212013_2cm_1455_medsand_15_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			262.9857	10.95774		
DISPERSIVITY (cm)			0.163558			
PULSE WIDTH (cm)			0.011868			
RF			1			
Co (mV)			2.788253			
RESDIUAL SUM OF SQUARES =				4.64E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		255.0961	262.9857	270.8753		
DISPERSIVITY(cm)		0.145567	0.163558	0.184821		
PULSE WIDTH (cm)		0.011275	0.011868	0.012461		
Co(mV)		2.64884	2.788253	2.927666		
CRITICAL RSS VALUE =			6.23E-05			

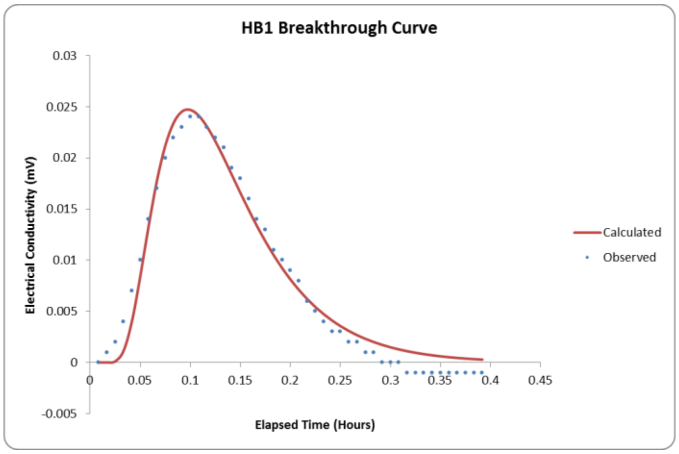
VelProbe output for 05212013_2cm_1455_medsand_15_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			188.7121	7.863005		
DISPERSIVITY (cm)			0.147915			
PULSE WIDTH (cm)			0.013958			
RF			1			
Co (mV)			2.290358			
RESDIUAL SUM OF SQUARES =				7.84E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			100			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		183.0508	188.7121	196.2606		
DISPERSIVITY(cm)		0.131644	0.147915	0.167143		
PULSE WIDTH (cm)		0.01326	0.013958	0.014656		
Co(mV)		2.17584	2.290358	2.404876		
CRITICAL RSS VALUE =			0.000105			

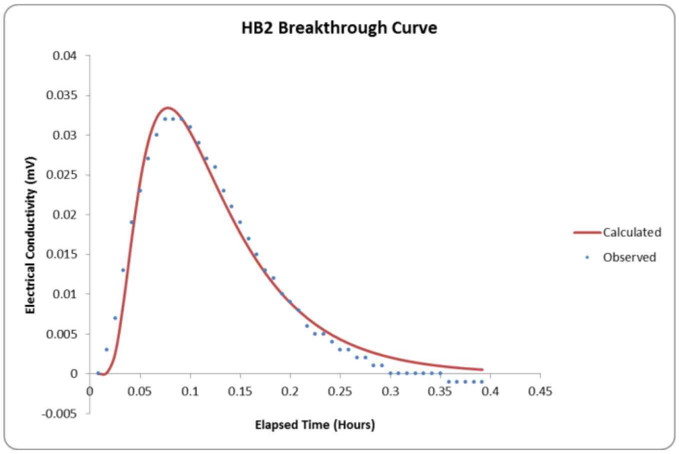
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.1635581	0.147914564	83.832772	53.918344	0.143722	262.9857	188.7121	214.9519	214.9519	-9.917E-15	.	1.463158	0.941053	0.002508	0.143695	214.9519	214.9519
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05212013_2cm_1519_medsand_15_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			270.9915	11.29131		
DISPERSIVITY (cm)			0.15476			
PULSE WIDTH (cm)			0.014964			
RF			1			
Co (mV)			2.412089			
RESDIUAL SUM OF SQUARES =				8.06E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		260.1518	270.9915	281.8311		
DISPERSIVITY(cm)		0.134642	0.15476	0.18107		
PULSE WIDTH (cm)		0.014066	0.014964	0.015862		
Co(mV)		2.267364	2.412089	2.556815		
CRITICAL RSS VALUE =			0.000109			

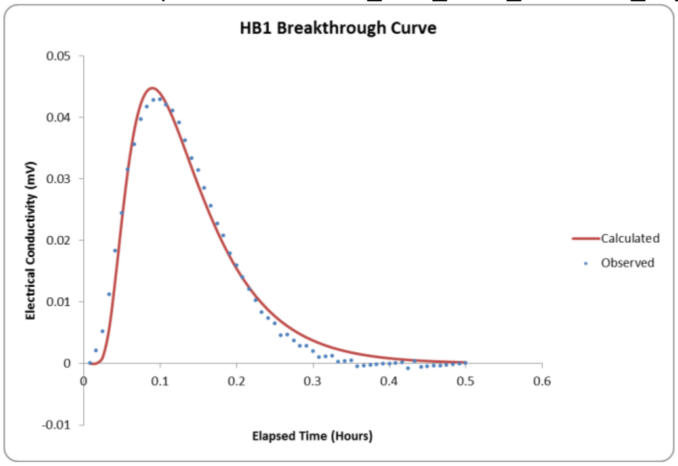
VelProbe output for 05212013_2cm_1519_medsand_15_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			196.3688	8.182035		
DISPERSIVITY (cm)			0.143835			
PULSE WIDTH (cm)			0.012224			
RF			1			
Co (mV)			2.912939			
RESDIUAL SUM OF SQUARES =				0.00012		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		188.5141	196.3688	204.2236		
DISPERSIVITY(cm)		0.126575	0.143835	0.165411		
PULSE WIDTH (cm)		0.011491	0.012224	0.012836		
Co(mV)		2.738162	2.912939	3.058586		
CRITICAL RSS VALUE =			0.000162			

Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.154760455	0.143835385	83.832772	53.918344	0.8186893	270.9915	196.3688	218.6564	218.6564	-6.499E-15	.	1.463158	0.941053	0.014286	0.818535	218.6564	218.6564
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05212013_2cm_1543_medsand_15_0.5gL_0.25 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES

		cm/hr
VELOCITY(cm/d)	274.2866	11.42861
DISPERSIVITY (cm)	0.199241	
PULSE WIDTH (cm)	0.018222	
RF	1	
Co (mV)	3.919408	

RESDIUAL SUM OF SQUARES = 0.000192

INITIAL GUESSES AND INPUT OF PARAMETERS

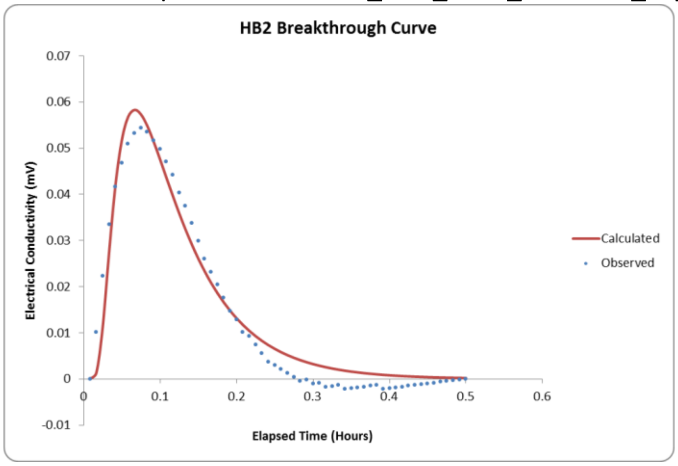
		FIX
VELOCITY(cm/d)	200	
DISPERSIVITY (cm)	0.1	
PULSE WIDTH (cm)	0.01	
RF	1	Y
Co (mV)	2	
DISTANCE FROM SOURCE (cm)	1.39	Y
DIFFUSION COEFF (cm^2/sec)	0.000001	Y

95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS

Parameter	Low	Optimized	High
VELOCITY(cm/d)	266.058	274.2866	282.5152
DISPERSIVITY(cm)	0.179317	0.199241	0.221158
PULSE WIDTH (cm)	0.017493	0.018222	0.01895
Co(mV)	3.762632	3.919408	4.076185

CRITICAL RSS VALUE = 0.000243

VelProbe output for 05212013_2cm_1543_medsand_15_0.5gL_0.25 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES

		cm/hr
VELOCITY(cm/d)	213.0771	8.878214
DISPERSIVITY (cm)	0.171015	
PULSE WIDTH (cm)	0.015539	
RF	1	
Co (mV)	4.192733	

RESDIUAL SUM OF SQUARES = 0.000776

INITIAL GUESSES AND INPUT OF PARAMETERS

		FIX
VELOCITY(cm/d)	200	
DISPERSIVITY (cm)	0.1	
PULSE WIDTH (cm)	0.01	
RF	1	Y
Co (mV)	2	
DISTANCE FROM SOURCE (cm)	0.894	Y
DIFFUSION COEFF (cm^2/sec)	0.000001	Y

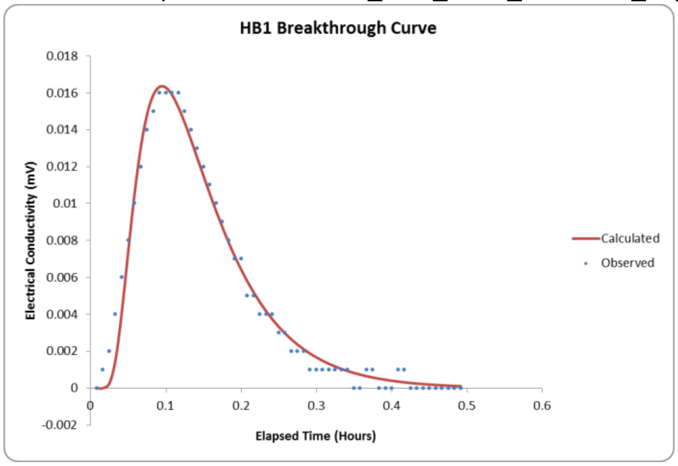
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS

Parameter	Low	Optimized	High
VELOCITY(cm/d)	200.2925	213.0771	225.8618
DISPERSIVITY(cm)	0.141943	0.171015	0.205218
PULSE WIDTH (cm)	0.014451	0.015539	0.016782
Co(mV)	3.899242	4.192733	4.528151

CRITICAL RSS VALUE = 0.000984

Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.171015279	0.199241114	53.918344	83.832772	6.3949938	213.0771	274.2866	201.118	201.118	1.06E-14	.	0.941053	1.463158	0.111593	6.393787	201.118	201.118
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05222013_2cm_1210_medsand_15_0.5gL_0.05 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES

		cm/hr
VELOCITY(cm/d)	261.0677	10.87782
DISPERSIVITY (cm)	0.196679	
PULSE WIDTH (cm)	0.006555	
RF	1	
Co (mV)	3.976278	

RESDIUAL SUM OF SQUARES = 2.59E-05

INITIAL GUESSES AND INPUT OF PARAMETERS

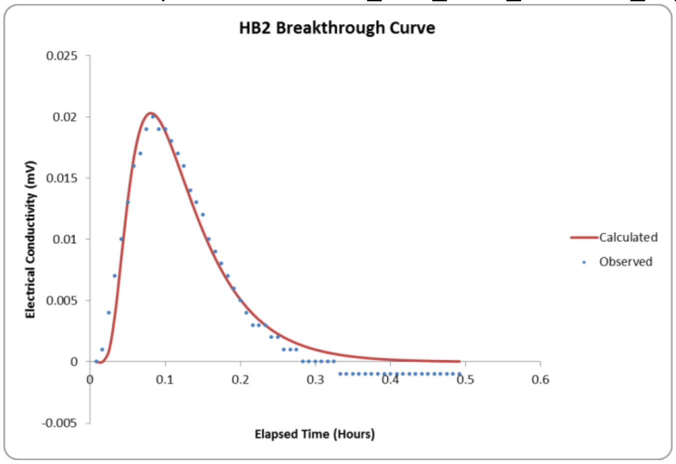
		FIX
VELOCITY(cm/d)	200	
DISPERSIVITY (cm)	0.1	
PULSE WIDTH (cm)	0.01	
RF	1	Y
Co (mV)	2	
DISTANCE FROM SOURCE (cm)	1.39	Y
DIFFUSION COEFF (cm^2/sec)	0.000001	Y

95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS

Parameter	Low	Optimized	High
VELOCITY(cm/d)	253.2357	261.0677	268.8998
DISPERSIVITY(cm)	0.177011	0.196679	0.218314
PULSE WIDTH (cm)	0.006293	0.006555	0.006817
Co(mV)	3.817227	3.976278	4.135329

CRITICAL RSS VALUE = 3.29E-05

VelProbe output for 05222013_2cm_1210_medsand_15_0.5gL_0.05 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES

		cm/hr
VELOCITY(cm/d)	197.1671	8.215294
DISPERSIVITY (cm)	0.126036	
PULSE WIDTH (cm)	0.00995	
RF	1	
Co (mV)	2.088113	

RESDIUAL SUM OF SQUARES = 7.32E-05

INITIAL GUESSES AND INPUT OF PARAMETERS

		FIX
VELOCITY(cm/d)	200	
DISPERSIVITY (cm)	0.1	
PULSE WIDTH (cm)	0.01	
RF	1	Y
Co (mV)	2	
DISTANCE FROM SOURCE (cm)	0.894	Y
DIFFUSION COEFF (cm^2/sec)	0.000001	Y

95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS

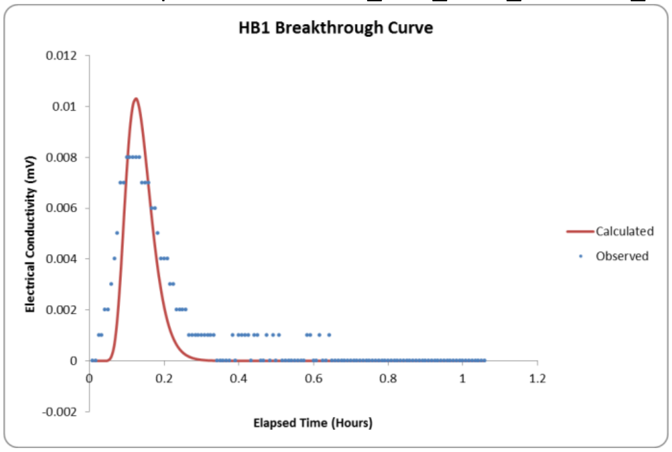
Parameter	Low	Optimized	High
VELOCITY(cm/d)	189.2804	197.1671	205.0537
DISPERSIVITY(cm)	0.108391	0.126036	0.147462
PULSE WIDTH (cm)	0.009353	0.00995	0.010547
Co(mV)	1.962826	2.088113	2.2134

CRITICAL RSS VALUE = 9.31E-05

Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.196679054	0.126035565	83.832772	53.918344	3.9570226	261.0677	197.1671	199.1492	199.1492	-3.568E-15	.	1.463158	0.941053	0.06905	3.956276	199.1492	199.1492
Probe 2	0.11403114	0.16141285	53.918344	83.832772	11.894025	256.677	312.969	212.3386	212.3386	3.346E-15							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

HB1 and HB2
HB3 and HB4

VelProbe output for 05222013_2cm_1240_medsand_15_0.5gL_0.03 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES

		cm/hr
VELOCITY(cm/d)	244.8875	10.20365
DISPERSIVITY (cm)	0.05	
PULSE WIDTH (cm)	0.004573	
RF	1	
Co (mV)	1.884527	

RESDIUAL SUM OF SQUARES = 0.032571

INITIAL GUESSES AND INPUT OF PARAMETERS

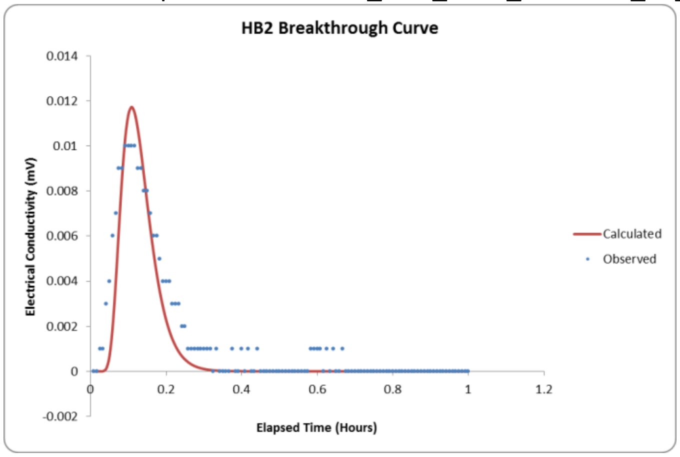
		FIX
VELOCITY(cm/d)	200	
DISPERSIVITY (cm)	0.05	Y
PULSE WIDTH (cm)	0.01	
RF	1	Y
Co (mV)	2	
DISTANCE FROM SOURCE (cm)	1.39	Y
DIFFUSION COEFF (cm^2/sec)	0.000001	Y

95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS

Parameter	Low	Optimized	High
No Convergence			
PULSE WIDTH (cm)	0	0.004573	0.009831
Co(mV)	0	1.884527	4.051734

CRITICAL RSS VALUE = 0.033449

VelProbe output for 05222013_2cm_1240_medsand_15_0.5gL_0.03 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES

		cm/hr
VELOCITY(cm/d)	177.0149	7.375621
DISPERSIVITY (cm)	0.05	
PULSE WIDTH (cm)	0.004201	
RF	1	
Co (mV)	1.986216	

RESDIUAL SUM OF SQUARES = 0.000111

INITIAL GUESSES AND INPUT OF PARAMETERS

		FIX
VELOCITY(cm/d)	200	
DISPERSIVITY (cm)	0.05	Y
PULSE WIDTH (cm)	0.01	
RF	1	Y
Co (mV)	2	
DISTANCE FROM SOURCE (cm)	0.894	Y
DIFFUSION COEFF (cm^2/sec)	0.000001	Y

95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS

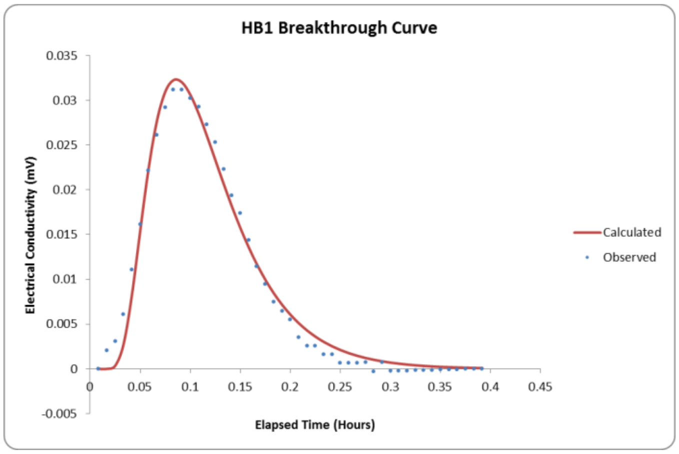
Parameter	Low	Optimized	High
VELOCITY(cm/d)	168.1642	177.0149	185.8656
PULSE WIDTH (cm)	0.003822	0.004201	0.004579
Co(mV)	1.807457	1.986216	2.164976

CRITICAL RSS VALUE = 0.000122

Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.05	0.05	83.832772	53.918344	0.6458364	244.8875	177.0149	198.2419	198.2419	0	.	1.463158	0.941053	0.01127	0.645715	198.2419	198.2419
Probe 2	0.05	0.05	53.918344	83.832772	168.6665	198.9668	356.5659	-384.096	-384.096	-9.771E-12							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

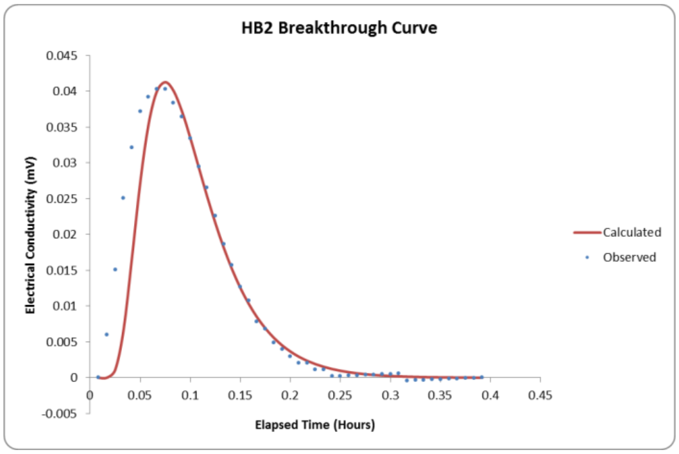
Probe 1 is HB1 and HB2
Probe 2 is HB 4 and HB3

VelProbe output for 05222013_2cm_1434_medsand_45_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			312.8091	13.03371		
DISPERSIVITY (cm)			0.144225			
PULSE WIDTH (cm)			0.011797			
RF			1			
Co (mV)			3.894508			
RESDIUAL SUM OF SQUARES =				7.27E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		303.4248	312.8091	322.1933		
DISPERSIVITY(cm)		0.12836	0.144225	0.162974		
PULSE WIDTH (cm)		0.011207	0.011797	0.012387		
Co(mV)		3.699782	3.894508	4.089233		
CRITICAL RSS VALUE =			9.82E-05			

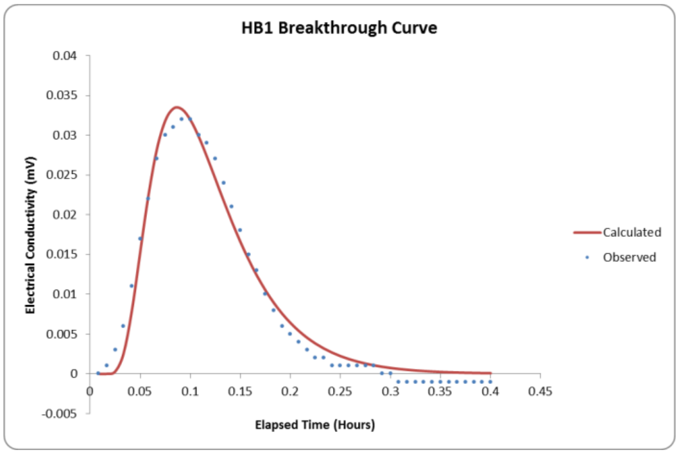
VelProbe output for 05222013_2cm_1434_medsand_45_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			233.765	9.740208		
DISPERSIVITY (cm)			0.08845			
PULSE WIDTH (cm)			0.014677			
RF			1			
Co (mV)			2.517996			
RESDIUAL SUM OF SQUARES =				4.61E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		231.4273	233.765	238.4403		
DISPERSIVITY(cm)		0.082258	0.08845	0.095526		
PULSE WIDTH (cm)		0.014237	0.014677	0.015117		
Co(mV)		2.442456	2.517996	2.593536		
CRITICAL RSS VALUE =			6.23E-05			

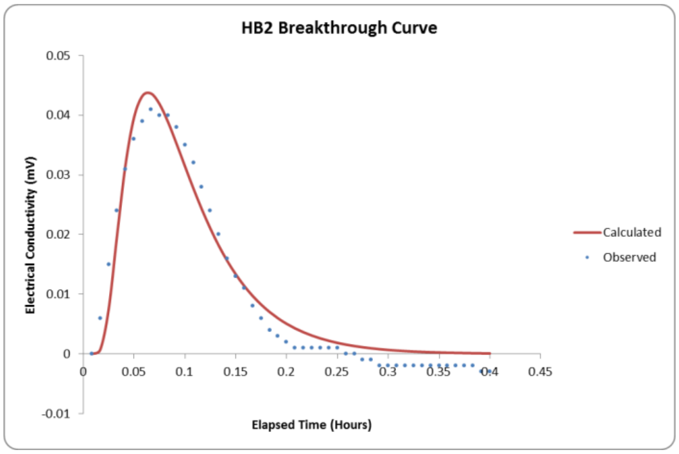
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.14422501	0.088449751	83.832772	53.918344	3.1102262	312.8091	233.765	242.1154	242.1154	-2.935E-15	.	1.463158	0.941053	0.054273	3.109639	242.1154	242.1154
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05222013_2cm_1507_medsand_45_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			310.2742	12.92809		
DISPERSIVITY (cm)			0.142644			
PULSE WIDTH (cm)			0.01886			
RF			1			
Co (mV)			2.509111			
RESDIUAL SUM OF SQUARES =				0.000107		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		300.966	310.2742	319.5825		
DISPERSIVITY(cm)		0.125527	0.142644	0.16404		
PULSE WIDTH (cm)		0.017728	0.01886	0.019992		
Co(mV)		2.358564	2.509111	2.659658		
CRITICAL RSS VALUE =			0.000143			

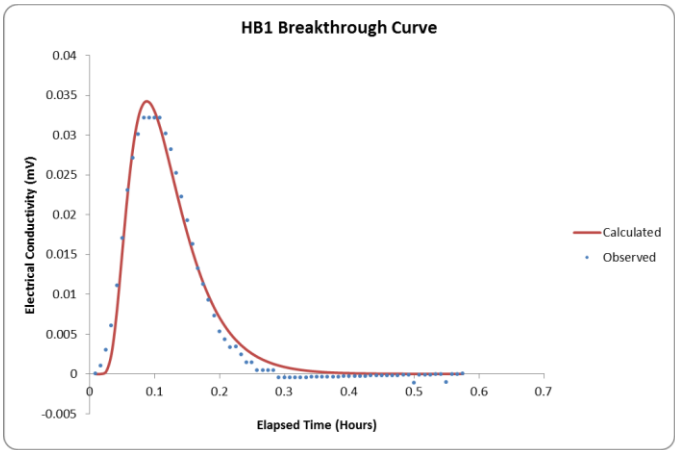
VelProbe output for 05222013_2cm_1507_medsand_45_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			246.9748	10.29062		
DISPERSIVITY (cm)			0.132419			
PULSE WIDTH (cm)			0.01262			
RF			1			
Co (mV)			3.596122			
RESDIUAL SUM OF SQUARES =				0.000372		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		232.1563	246.9748	261.7932		
DISPERSIVITY(cm)		0.107259	0.132419	0.162875		
PULSE WIDTH (cm)		0.011484	0.01262	0.013756		
Co(mV)		3.272471	3.596122	3.919772		
CRITICAL RSS VALUE =			0.000499			

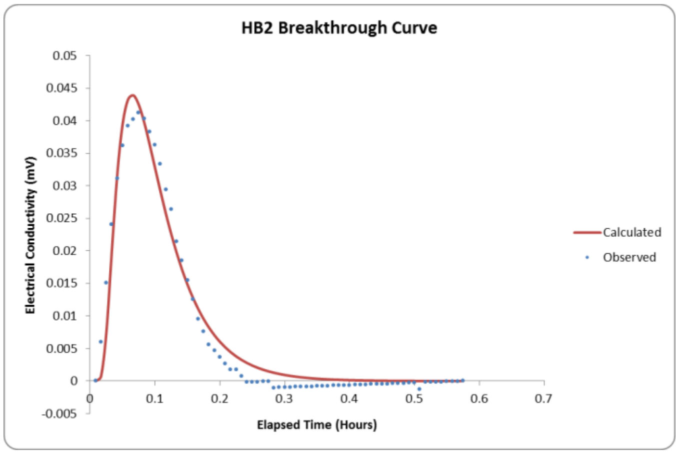
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.142643828	0.132418673	83.832772	53.918344	8.7219099	310.2742	246.9748	219.742	219.742	-3.234E-15	.	1.463158	0.941053	0.152197	8.720265	219.742	219.742
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05222013_2cm_1532_medsand_45_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			305.8339	12.74308		
DISPERSIVITY (cm)			0.145257			
PULSE WIDTH (cm)			0.015551			
RF			1			
Co (mV)			3.136057			
RESDIUAL SUM OF SQUARES =				0.000108		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		299.7172	305.8339	311.9506		
DISPERSIVITY(cm)		0.130732	0.145257	0.161236		
PULSE WIDTH (cm)		0.014929	0.015551	0.016173		
Co(mV)		3.010614	3.136057	3.261499		
CRITICAL RSS VALUE =			0.000133			

VelProbe output for 05222013_2cm_1532_medsand_45_0.5gL_0.1 – Half Bridge 2



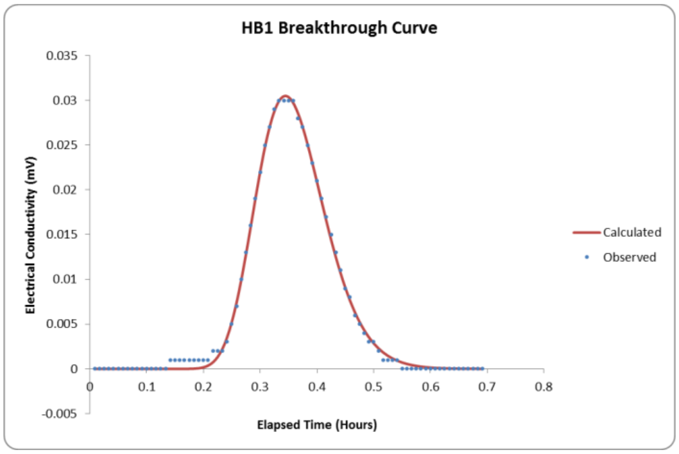
OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			239.1509	9.964622		
DISPERSIVITY (cm)			0.138874			
PULSE WIDTH (cm)			0.013902			
RF			1			
Co (mV)			3.329485			
RESDIUAL SUM OF SQUARES =				0.000321		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		229.5849	239.1509	251.1085		
DISPERSIVITY(cm)		0.119432	0.138874	0.162483		
PULSE WIDTH (cm)		0.013068	0.013902	0.014736		
Co(mV)		3.129716	3.329485	3.529254		
CRITICAL RSS VALUE =			0.000394			

Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.145257432	0.138874296	83.832772	53.918344	7.0017185	305.8339	239.1509	222.1673	222.1673	0	.	1.463158	0.941053	0.12218	7.000398	222.1673	222.1673
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VELPROBE OUTPUT

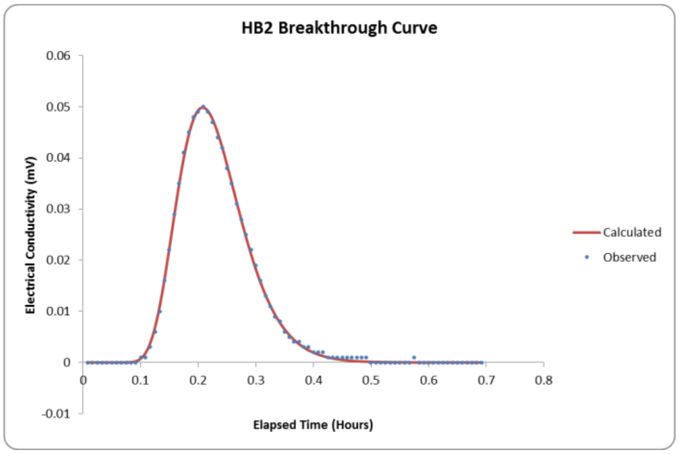
11 cm PVP Data for Medium Sand

VelProbe output for 05122013_11cm_1308_medsand_45_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			515.3138	21.47141		
DISPERSIVITY (cm)			0.111581			
PULSE WIDTH (cm)			0.019326			
RF			1			
Co (mV)			5.082405			
RESDIUAL SUM OF SQUARES =				1.54E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			7.62			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		515.3138	515.3138	515.3138		
DISPERSIVITY(cm)		0.108234	0.111581	0.114929		
PULSE WIDTH (cm)		0.019132	0.019326	0.019519		
Co(mV)		5.031581	5.082405	5.133229		
CRITICAL RSS VALUE =			1.83E-05			

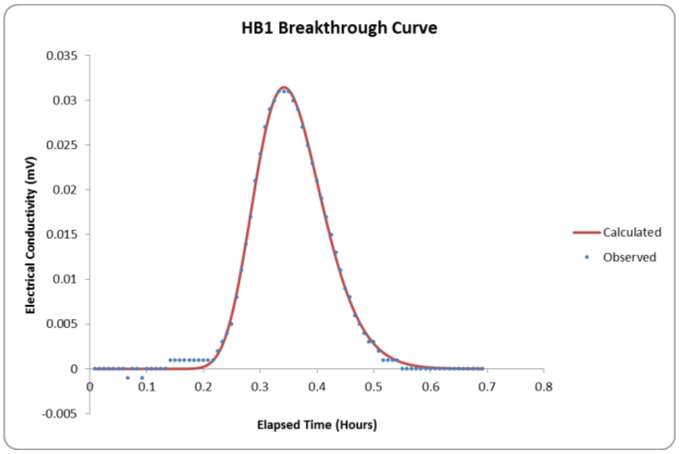
VelProbe output for 05122013_11cm_1308_medsand_45_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			499.9248	20.8302		
DISPERSIVITY (cm)			0.15395			
PULSE WIDTH (cm)			0.022412			
RF			1			
Co (mV)			6.430854			
RESDIUAL SUM OF SQUARES =				1.58E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.63			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		499.9248	499.9248	499.9248		
DISPERSIVITY(cm)		0.150871	0.15395	0.157029		
PULSE WIDTH (cm)		0.022188	0.022412	0.022412		
Co(mV)		6.366545	6.430854	6.430854		
CRITICAL RSS VALUE =			1.88E-05			

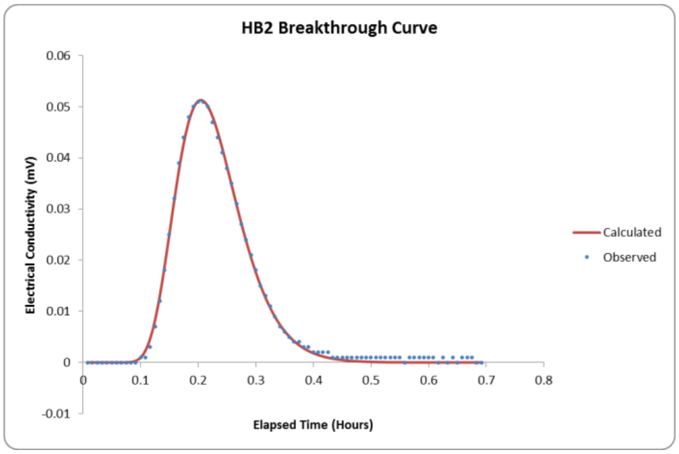
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.111581198	0.153949979	77.000677	46.786501	42.521277	515.3138	499.9248	281.5754	281.5754	0	.	1.343915	0.816578	0.741996	42.51326	281.5754	281.5754
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05122013_11cm_1347_medsand_45_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			518.685	21.61188		
DISPERSIVITY (cm)			0.11393			
PULSE WIDTH (cm)			0.019485			
RF			1			
Co (mV)			5.253005			
RESDIUAL SUM OF SQUARES =				1.72E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			7.62			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		518.685	518.685	518.685		
DISPERSIVITY(cm)		0.110512	0.11393	0.117348		
PULSE WIDTH (cm)		0.01929	0.019485	0.01968		
Co(mV)		5.200475	5.253005	5.305535		
CRITICAL RSS VALUE =			2.05E-05			

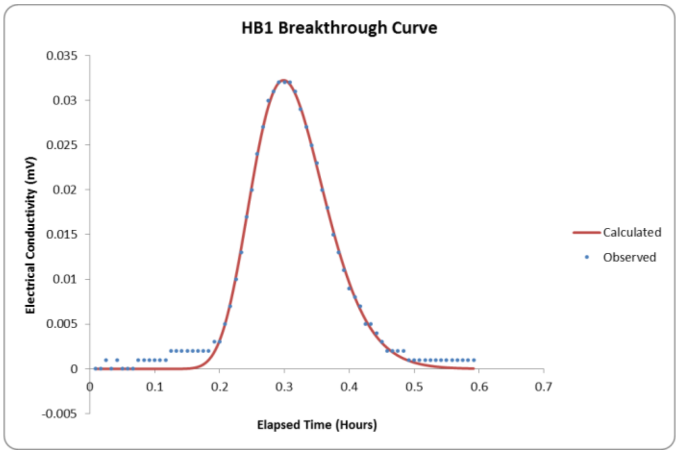
VelProbe output for 05122013_11cm_1347_medsand_45_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			506.9718	21.12383		
DISPERSIVITY (cm)			0.156612			
PULSE WIDTH (cm)			0.012245			
RF			1			
Co (mV)			12.21716			
RESDIUAL SUM OF SQUARES =				4.06E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.63			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		506.9718	506.9718	506.9718		
DISPERSIVITY(cm)		0.151914	0.156612	0.16131		
PULSE WIDTH (cm)		0.012122	0.012245	0.012367		
Co(mV)		12.09499	12.21716	12.33933		
CRITICAL RSS VALUE =			4.83E-05			

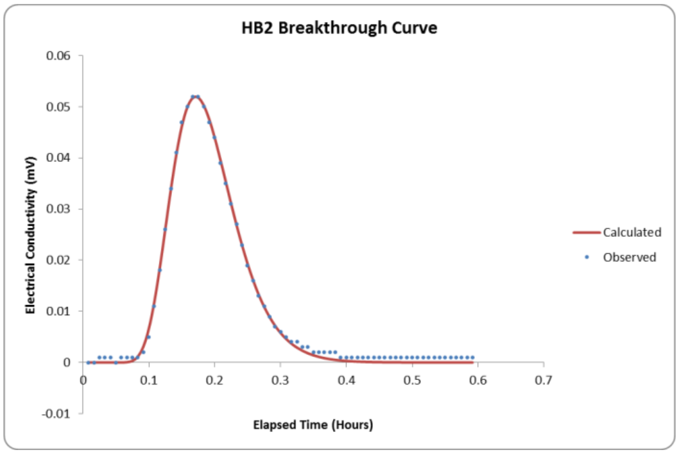
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.113929975	0.156611882	77.000677	46.786501	44.015038	518.685	506.9718	282.3496	282.3496	-1.007E-14	.	1.343915	0.816578	0.768062	44.00673	282.3496	282.3496
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05132013_11cm_1200_medsand_45_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			591.1542	24.63142		
DISPERSIVITY (cm)			0.133608			
PULSE WIDTH (cm)			0.012211			
RF			1			
Co (mV)			9.280019			
RESDIUAL SUM OF SQUARES =				4.71E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			7.62			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		591.1542	591.1542	591.1542		
DISPERSIVITY(cm)		0.125591	0.133608	0.14296		
PULSE WIDTH (cm)		0.011967	0.012211	0.012455		
Co(mV)		9.094419	9.280019	9.46562		
CRITICAL RSS VALUE =			5.76E-05			

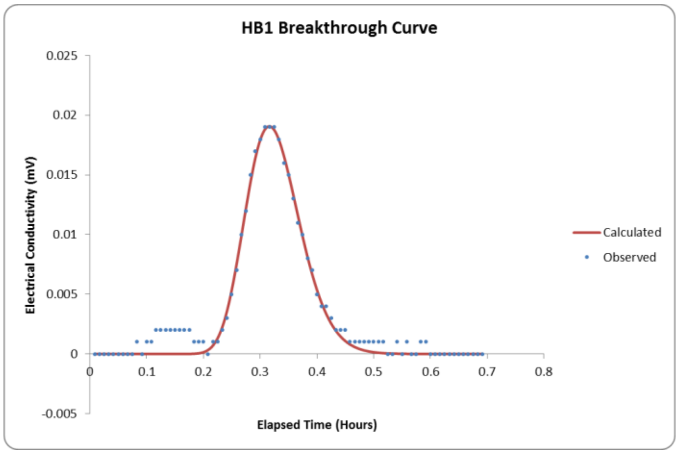
VelProbe output for 05132013_11cm_1200_medsand_45_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			603.6264	25.1511		
DISPERSIVITY (cm)			0.166107			
PULSE WIDTH (cm)			0.031431			
RF			1			
Co (mV)			4.948112			
RESDIUAL SUM OF SQUARES =				4.47E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.63			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		603.6264	603.6264	603.6264		
DISPERSIVITY(cm)		0.159463	0.166107	0.172751		
PULSE WIDTH (cm)		0.031116	0.031431	0.031745		
Co(mV)		4.898631	4.948112	4.997593		
CRITICAL RSS VALUE =			5.47E-05			

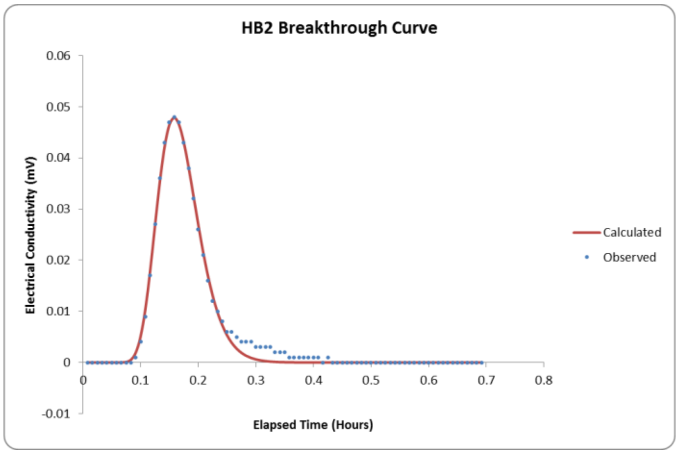
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.133607513	0.166107057	77.000677	46.786501	53.12164	591.1542	603.6264	319.1771	319.1771	-4.452E-15	.	1.343915	0.816578	0.926973	53.11162	319.1771	319.1771
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05132013_11cm_1259_medsand_75_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			565.8705	23.57794		
DISPERSIVITY (cm)			0.082857			
PULSE WIDTH (cm)			0.012429			
RF			1			
Co (mV)			4.278992			
RESDIUAL SUM OF SQUARES =				5.04E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			7.62			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		560.2118	565.8705	571.5292		
DISPERSIVITY(cm)		0.074571	0.082857	0.093629		
PULSE WIDTH (cm)		0.011808	0.012429	0.013051		
Co(mV)		4.065043	4.278992	4.492942		
CRITICAL RSS VALUE =			6E-05			

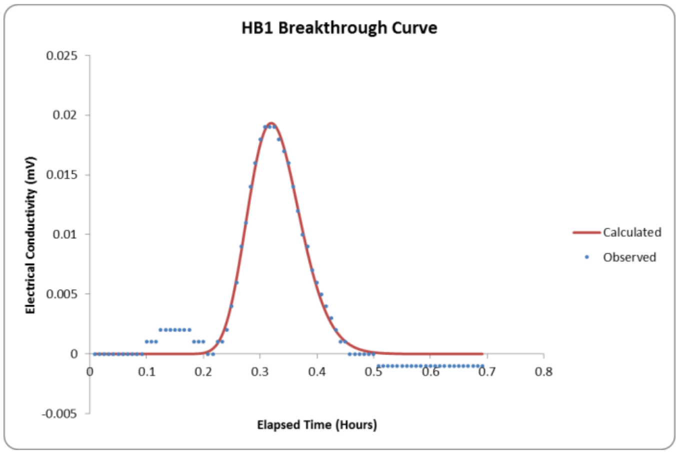
VelProbe output for 05132013_11cm_1259_medsand_75_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			669.2882	27.88701		
DISPERSIVITY (cm)			0.110265			
PULSE WIDTH (cm)			0.014072			
RF			1			
Co (mV)			8.407635			
RESDIUAL SUM OF SQUARES =				9.07E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.63			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		669.2882	669.2882	669.2882		
DISPERSIVITY(cm)		0.102546	0.110265	0.117983		
PULSE WIDTH (cm)		0.01365	0.014072	0.014495		
Co(mV)		8.155406	8.407635	8.659864		
CRITICAL RSS VALUE =			0.000108			

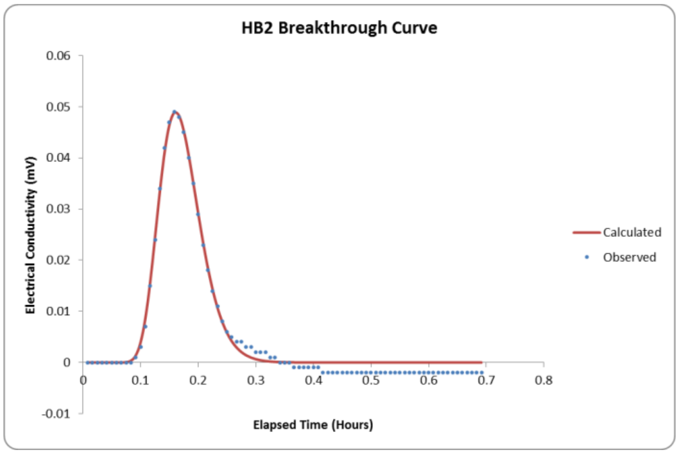
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.082857152	0.110264581	77.000677	46.786501	83.27576	565.8705	669.2882	359.1915	359.1915	-3.956E-15	.	1.343915	0.816578	1.453162	83.26005	359.1915	359.1915
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05132013_11cm_1337_medsand_75_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			560.7364	23.36402		
DISPERSIVITY (cm)			0.076437			
PULSE WIDTH (cm)			0.006442			
RF			1			
Co (mV)			8.057189			
RESDIUAL SUM OF SQUARES =				6.29E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			7.62			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		555.1291	560.7364	566.3438		
DISPERSIVITY(cm)		0.068029	0.076437	0.087138		
PULSE WIDTH (cm)		0.00612	0.006442	0.006764		
Co(mV)		7.654329	8.057189	8.460048		
CRITICAL RSS VALUE =			7.48E-05			

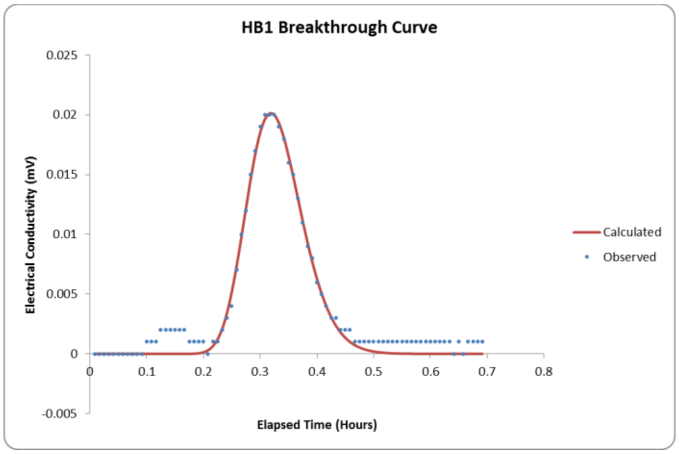
VelProbe output for 05132013_11cm_1337_medsand_75_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			659.8985	27.49577		
DISPERSIVITY (cm)			0.105241			
PULSE WIDTH (cm)			0.007157			
RF			1			
Co (mV)			16.54813			
RESDIUAL SUM OF SQUARES =				0.000171		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.63			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		653.2995	659.8985	666.4975		
DISPERSIVITY(cm)		0.09577	0.105241	0.115765		
PULSE WIDTH (cm)		0.006871	0.007157	0.007443		
Co(mV)		15.88621	16.54813	17.21006		
CRITICAL RSS VALUE =			0.000203			

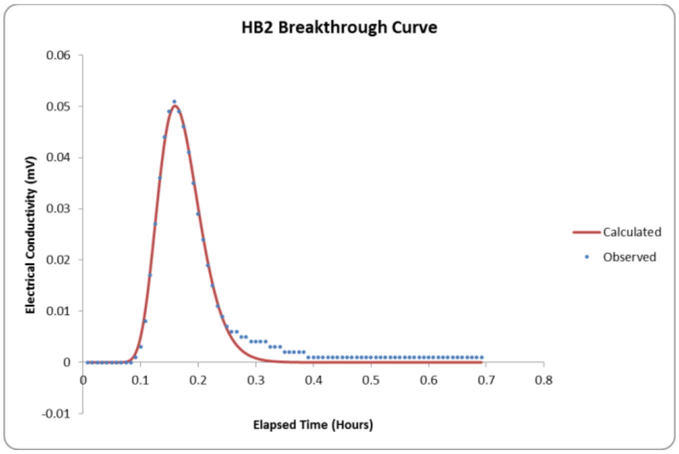
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.076437232	0.105241301	77.000677	46.786501	82.371149	560.7364	659.8985	352.5316	352.5316	0	.	1.343915	0.816578	1.437377	82.35561	352.5316	352.5316
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05132013_11cm_1431_medsand_75_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			560.7501	23.36459		
DISPERSIVITY (cm)			0.083365			
PULSE WIDTH (cm)			0.010802			
RF			1			
Co (mV)			5.214773			
RESDIUAL SUM OF SQUARES =				5.8E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			7.62			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		555.1426	560.7501	566.3576		
DISPERSIVITY(cm)		0.074194	0.083365	0.094202		
PULSE WIDTH (cm)		0.010262	0.010802	0.011343		
Co(mV)		4.954034	5.214773	5.475511		
CRITICAL RSS VALUE =			6.89E-05			

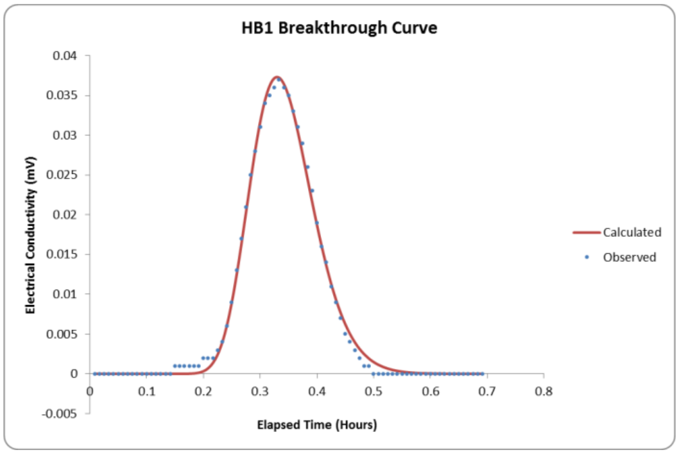
VelProbe output for 05132013_11cm_1431_medsand_75_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			660.845	27.53521		
DISPERSIVITY (cm)			0.112938			
PULSE WIDTH (cm)			0.010183			
RF			1			
Co (mV)			12.29097			
RESDIUAL SUM OF SQUARES =				0.000167		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.63			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		654.2366	660.845	667.4535		
DISPERSIVITY(cm)		0.102773	0.112938	0.123102		
PULSE WIDTH (cm)		0.009776	0.010183	0.01059		
Co(mV)		11.79933	12.29097	12.78261		
CRITICAL RSS VALUE =			0.000199			

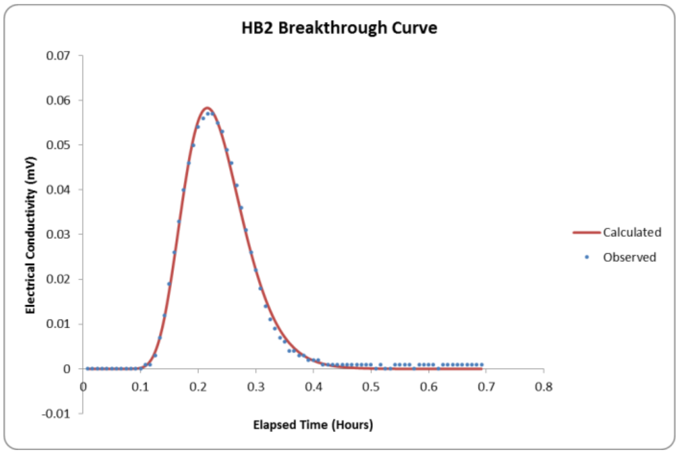
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.083364543	0.112937884	77.000677	46.786501	82.626619	560.7501	660.845	353.4852	353.4852	8.04E-15	.	1.343915	0.816578	1.441835	82.61103	353.4852	353.4852
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05132013_11cm_1537_medsand_30_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			539.7127	22.48803		
DISPERSIVITY (cm)			0.10268			
PULSE WIDTH (cm)			0.021721			
RF			1			
Co (mV)			5.313792			
RESDIUAL SUM OF SQUARES =				3.72E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			7.62			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		539.7127	539.7127	539.7127		
DISPERSIVITY(cm)		0.098572	0.10268	0.106787		
PULSE WIDTH (cm)		0.021286	0.021721	0.022155		
Co(mV)		5.207516	5.313792	5.420068		
CRITICAL RSS VALUE =			4.42E-05			

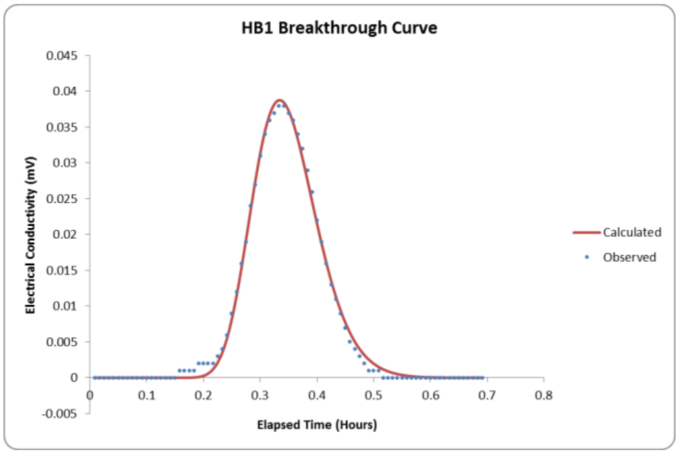
VelProbe output for 05132013_11cm_1537_medsand_30_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			486.9434	20.28931		
DISPERSIVITY (cm)			0.128843			
PULSE WIDTH (cm)			0.032662			
RF			1			
Co (mV)			4.742959			
RESDIUAL SUM OF SQUARES =				7.06E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.63			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		486.9434	486.9434	486.9434		
DISPERSIVITY(cm)		0.123689	0.128843	0.133996		
PULSE WIDTH (cm)		0.032335	0.032662	0.032988		
Co(mV)		4.69553	4.742959	4.790389		
CRITICAL RSS VALUE =			8.39E-05			

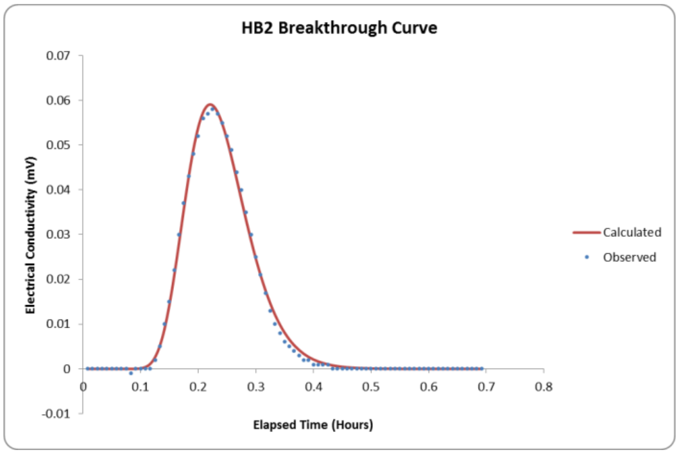
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.102679622	0.128842627	77.000677	46.786501	29.389603	539.7127	486.9434	314.4206	314.4206	-4.52E-15	.	1.343915	0.816578	0.512849	29.38406	314.4206	314.4206
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05132013_11cm_1617_medsand_30_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			532.0533	22.16889		
DISPERSIVITY (cm)			0.103787			
PULSE WIDTH (cm)			0.019811			
RF			1			
Co (mV)			6.087577			
RESDIUAL SUM OF SQUARES =				4.04E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			7.62			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		532.0533	532.0533	532.0533		
DISPERSIVITY(cm)		0.099635	0.103787	0.107938		
PULSE WIDTH (cm)		0.019415	0.019811	0.020208		
Co(mV)		5.965825	6.087577	6.209329		
CRITICAL RSS VALUE =			4.8E-05			

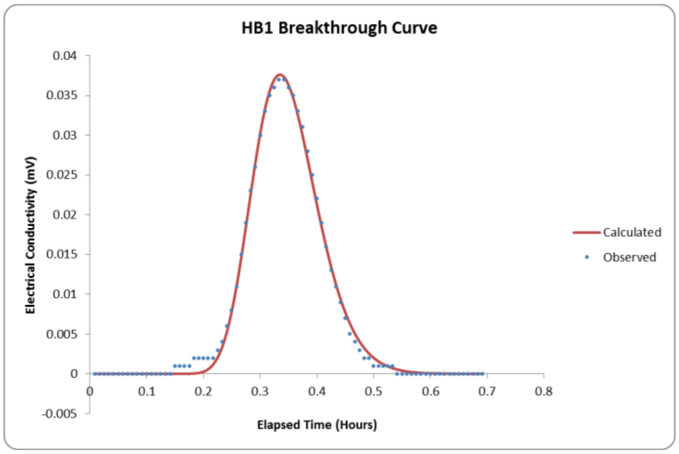
VelProbe output for 05132013_11cm_1617_medsand_30_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			476.8013	19.86672		
DISPERSIVITY (cm)			0.123318			
PULSE WIDTH (cm)			0.034595			
RF			1			
Co (mV)			4.447669			
RESDIUAL SUM OF SQUARES =				6.62E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.63			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		476.8013	476.8013	476.8013		
DISPERSIVITY(cm)		0.119618	0.123318	0.128251		
PULSE WIDTH (cm)		0.03425	0.034595	0.034941		
Co(mV)		4.403192	4.447669	4.492145		
CRITICAL RSS VALUE =			7.87E-05			

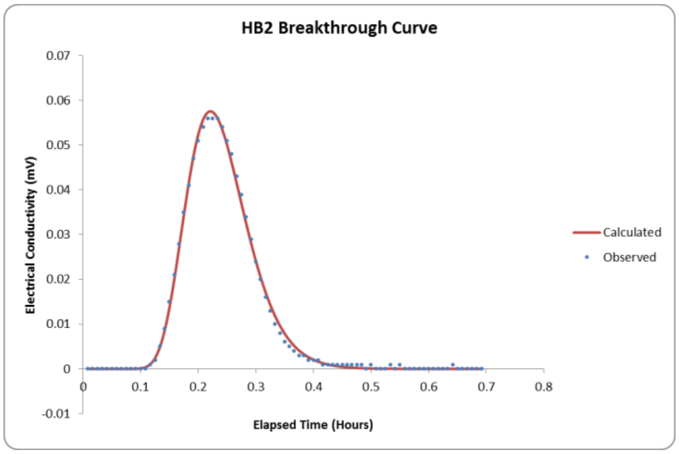
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.103786538	0.123317894	77.000677	46.786501	28.306111	532.0533	476.8013	312.4145	312.4145	4.549E-15	.	1.343915	0.816578	0.493942	28.30077	312.4145	312.4145
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05132013_11cm_1700_medsand_30_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			531.1143	22.12976		
DISPERSIVITY (cm)			0.104396			
PULSE WIDTH (cm)			0.018778			
RF			1			
Co (mV)			6.248801			
RESDIUAL SUM OF SQUARES =				3.48E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			7.62			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		531.1143	531.1143	531.1143		
DISPERSIVITY(cm)		0.10022	0.104396	0.108572		
PULSE WIDTH (cm)		0.01859	0.018778	0.018966		
Co(mV)		6.186313	6.248801	6.311289		
CRITICAL RSS VALUE =			4.13E-05			

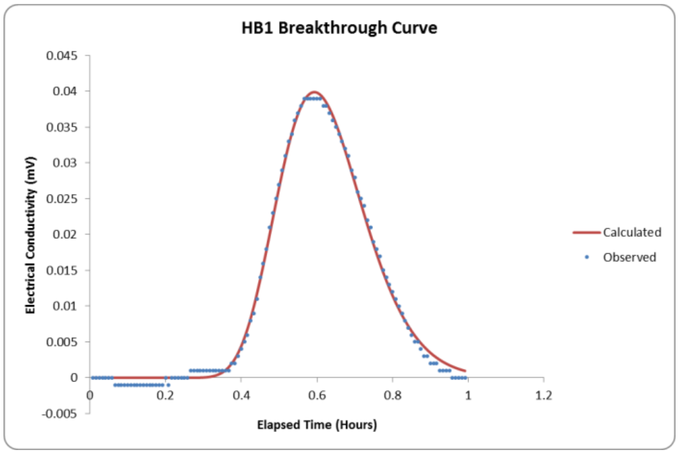
VelProbe output for 05132013_11cm_1700_medsand_30_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			476.0389	19.83495		
DISPERSIVITY (cm)			0.122464			
PULSE WIDTH (cm)			0.033376			
RF			1			
Co (mV)			4.476043			
RESDIUAL SUM OF SQUARES =				5.38E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.63			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		476.0389	476.0389	476.0389		
DISPERSIVITY(cm)		0.11879	0.122464	0.126138		
PULSE WIDTH (cm)		0.033042	0.033376	0.03371		
Co(mV)		4.431283	4.476043	4.520804		
CRITICAL RSS VALUE =			6.4E-05			

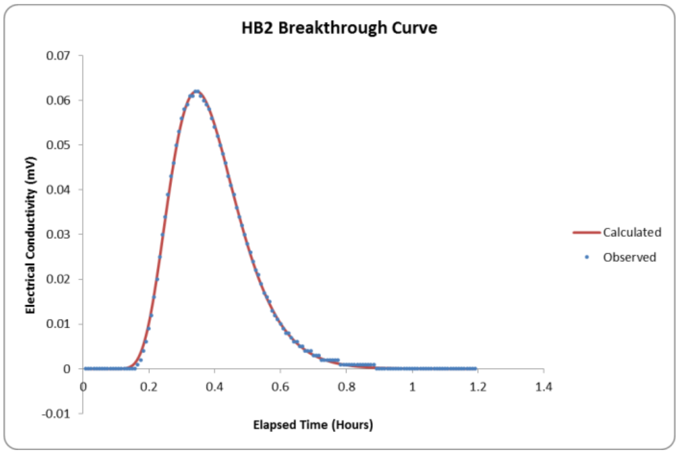
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.104395991	0.122463921	77.000677	46.786501	28.332488	531.1143	476.0389	311.8017	311.8017	4.558E-15	.	1.343915	0.816578	0.494402	28.32714	311.8017	311.8017
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05232013_11cm_1509_medsand_45_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			297.3062	12.38776		
DISPERSIVITY (cm)			0.135809			
PULSE WIDTH (cm)			0.019123			
RF			1			
Co (mV)			7.395763			
RESDIUAL SUM OF SQUARES =				6.69E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			7.62			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		297.3062	297.3062	297.3062		
DISPERSIVITY(cm)		0.131734	0.135809	0.139883		
PULSE WIDTH (cm)		0.018932	0.019123	0.019314		
Co(mV)		7.321805	7.395763	7.469721		
CRITICAL RSS VALUE =			7.55E-05			

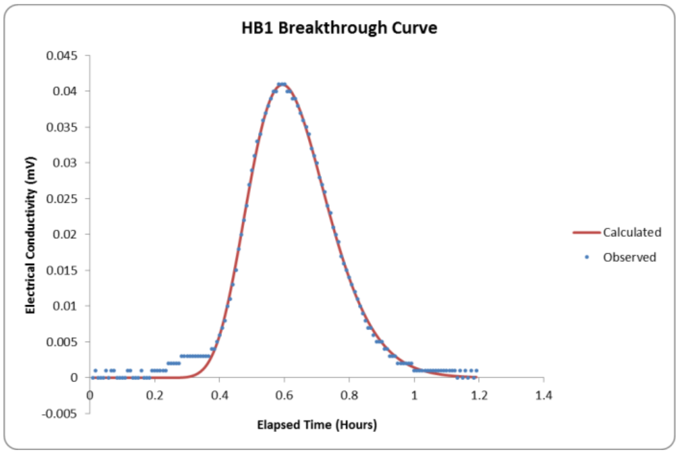
VelProbe output for 05232013_11cm_1509_medsand_45_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			295.7841	12.32434		
DISPERSIVITY (cm)			0.194879			
PULSE WIDTH (cm)			0.028981			
RF			1			
Co (mV)			6.897165			
RESDIUAL SUM OF SQUARES =				2.94E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.63			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		295.7841	295.7841	295.7841		
DISPERSIVITY(cm)		0.19293	0.194879	0.196828		
PULSE WIDTH (cm)		0.028981	0.028981	0.028981		
Co(mV)		6.897165	6.897165	6.897165		
CRITICAL RSS VALUE =			3.25E-05			

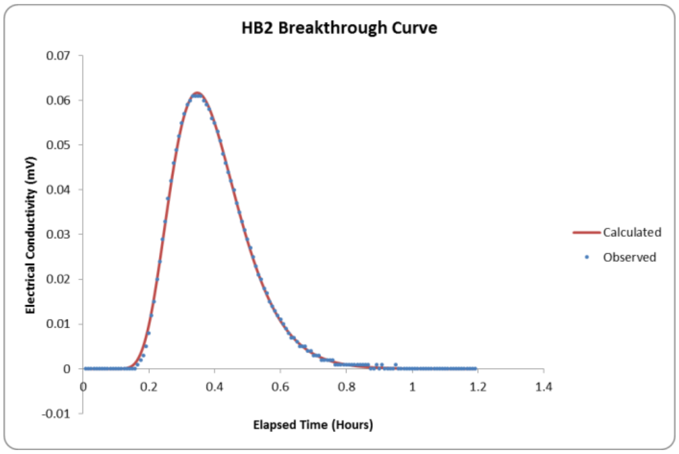
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.194878736	0.135808627	46.786501	77.000677	47.635926	295.7841	297.3062	160.8259	160.8259	-8.836E-15	.	0.816578	1.343915	0.831247	47.62694	160.8259	160.8259
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05232013_11cm_1623_medsand_45_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			295.5203	12.31334		
DISPERSIVITY (cm)			0.155436			
PULSE WIDTH (cm)			0.019896			
RF			1			
Co (mV)			7.778457			
RESDIUAL SUM OF SQUARES =				0.000117		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			7.62			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		295.5203	295.5203	295.5203		
DISPERSIVITY(cm)		0.150773	0.155436	0.160099		
PULSE WIDTH (cm)		0.019697	0.019896	0.020095		
Co(mV)		7.700673	7.778457	7.856242		
CRITICAL RSS VALUE =			0.000129			

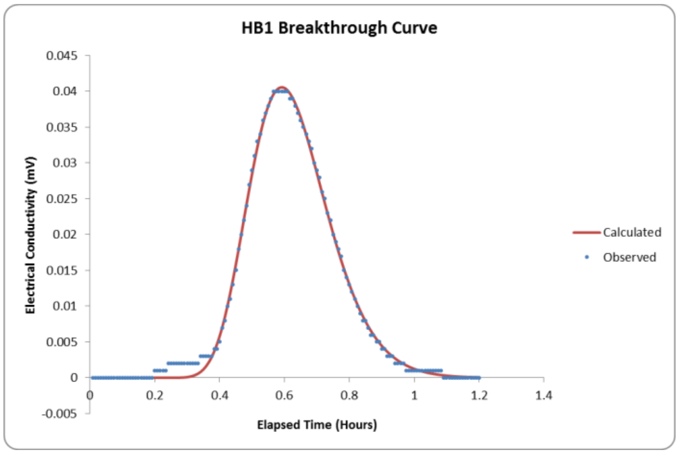
VelProbe output for 05232013_11cm_1623_medsand_45_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			293.4844	12.22852		
DISPERSIVITY (cm)			0.196269			
PULSE WIDTH (cm)			0.029845			
RF			1			
Co (mV)			6.68252			
RESDIUAL SUM OF SQUARES =				3.56E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.63			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		293.4844	293.4844	293.4844		
DISPERSIVITY(cm)		0.194306	0.196269	0.198231		
PULSE WIDTH (cm)		0.029845	0.029845	0.029845		
Co(mV)		6.68252	6.68252	6.68252		
CRITICAL RSS VALUE =			3.94E-05			

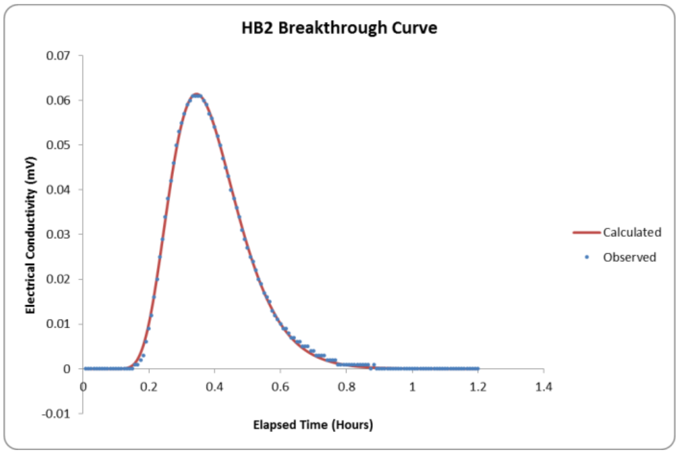
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.155435861	0.196268578	77.000677	46.786501	47.267175	295.5203	293.4844	159.9328	159.9328	-4.443E-15	.	1.343915	0.816578	0.824812	47.25826	159.9328	159.9328
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 05232013_11cm_1915_medsand_45_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			296.8501	12.36876		
DISPERSIVITY (cm)			0.151723			
PULSE WIDTH (cm)			0.026032			
RF			1			
Co (mV)			5.823899			
RESDIUAL SUM OF SQUARES =				7.41E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			7.62			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		296.8501	296.8501	296.8501		
DISPERSIVITY(cm)		0.147172	0.151723	0.156275		
PULSE WIDTH (cm)		0.025772	0.026032	0.026292		
Co(mV)		5.76566	5.823899	5.882138		
CRITICAL RSS VALUE =			8.19E-05			

VelProbe output for 05232013_11cm_1915_medsand_45_0.5gL_0.5 – Half Bridge 2



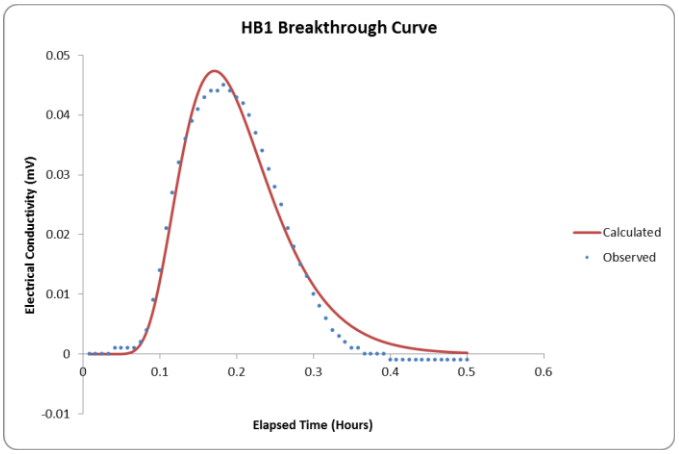
OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			295.6866	12.32027		
DISPERSIVITY (cm)			0.195489			
PULSE WIDTH (cm)			0.035259			
RF			1			
Co (mV)			5.620241			
RESDIUAL SUM OF SQUARES =				3.27E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.63			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		295.6866	295.6866	295.6866		
DISPERSIVITY(cm)		0.193534	0.195489	0.197444		
PULSE WIDTH (cm)		0.035259	0.035259	0.035259		
Co(mV)		5.620241	5.620241	5.620241		
CRITICAL RSS VALUE =			3.62E-05			

Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.151723433	0.195489085	77.000677	46.786501	47.886281	296.8501	295.6866	160.5332	160.5332	4.426E-15	.	1.343915	0.816578	0.835616	47.87725	160.5332	160.5332
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VELPROBE OUTPUT

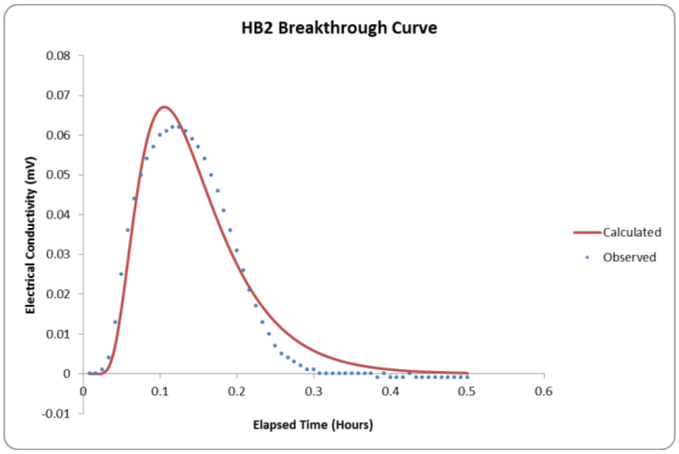
6 cm PVP Data for Fine Sand

VelProbe output for 0605013_6cm_1514_finesand_15_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			511.6046	21.31686		
DISPERSIVITY (cm)			0.223336			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			15.16048			
RESDIUAL SUM OF SQUARES =				0.000275		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		506.4886	511.6046	521.8367		
DISPERSIVITY(cm)		0.203236	0.223336	0.24567		
Co(mV)		14.55407	15.16048	15.7669		
CRITICAL RSS VALUE =			0.000329			

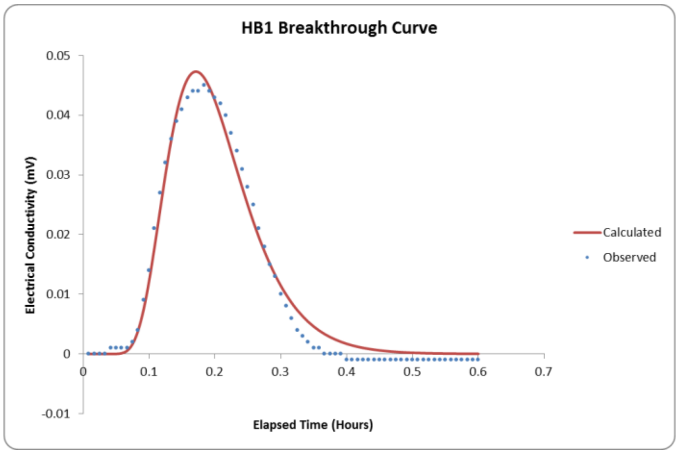
VelProbe output for 0605013_6cm_1514_finesand_15_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			455.2808	18.97003		
DISPERSIVITY (cm)			0.27652			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			17.66797			
RESDIUAL SUM OF SQUARES =				0.001041		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		441.6224	455.2808	473.492		
DISPERSIVITY(cm)		0.240572	0.27652	0.320763		
Co(mV)		16.60789	17.66797	18.72805		
CRITICAL RSS VALUE =			0.001246			

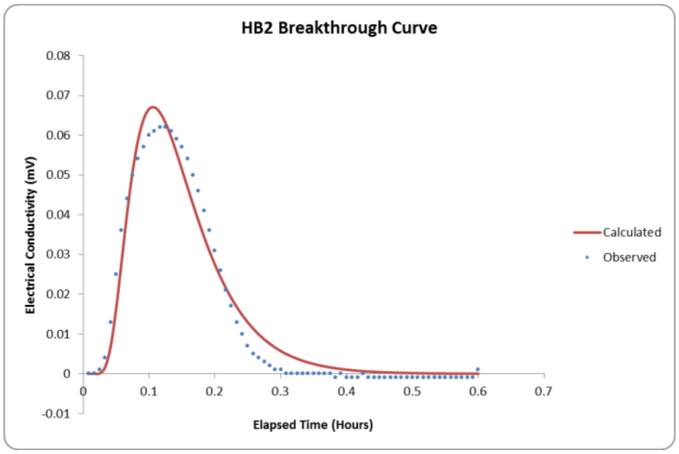
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.22333599	0.276520091	77.92226	48.128455	26.242322	511.6046	455.2808	304.7414	304.7414	-4.663E-15	.	1.36	0.84	0.457929	26.23737	304.7414	304.7414
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0605013_6cm_1548_finesand_15_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			511.6488	21.3187		
DISPERSIVITY (cm)			0.222499			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			15.14291			
RESDIUAL SUM OF SQUARES =				0.000288		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		506.5323	511.6488	516.7653		
DISPERSIVITY(cm)		0.204699	0.222499	0.242524		
Co(mV)		14.5372	15.14291	15.5972		
CRITICAL RSS VALUE =			0.000335			

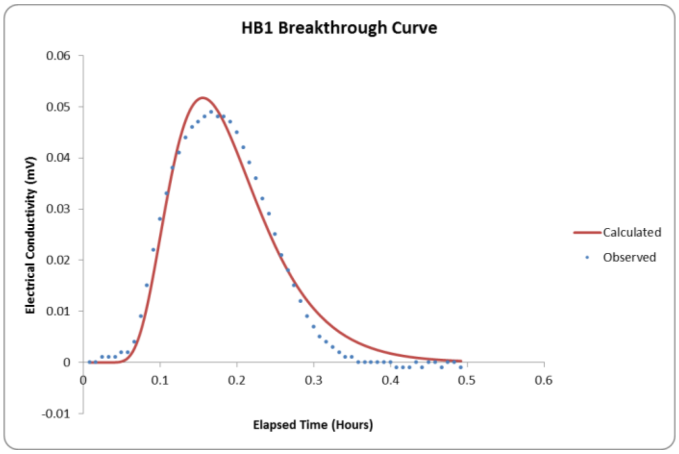
VelProbe output for 0605013_6cm_1548_finesand_15_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			454.8253	18.95106		
DISPERSIVITY (cm)			0.274538			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			17.60046			
RESDIUAL SUM OF SQUARES =				0.001055		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		441.1806	454.8253	468.4701		
DISPERSIVITY(cm)		0.241594	0.274538	0.312974		
Co(mV)		16.72044	17.60046	18.48048		
CRITICAL RSS VALUE =			0.001226			

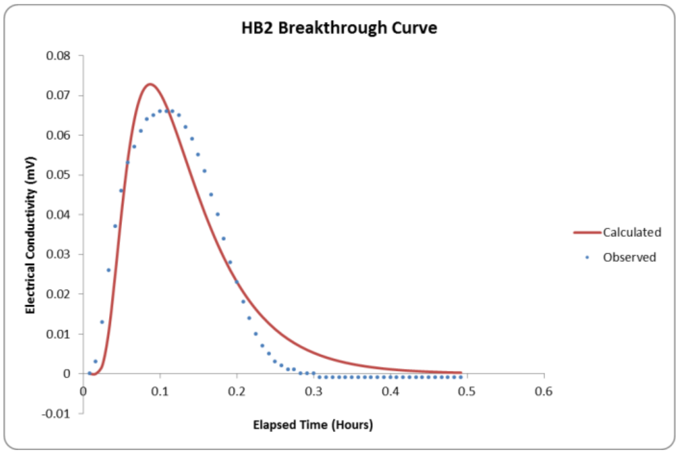
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.222498998	0.274538358	77.92226	48.128455	26.073367	511.6488	454.8253	305.1849	305.1849	4.656E-15	.	1.36	0.84	0.45498	26.06845	305.1849	305.1849
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0605013_6cm_1625_finesand_15_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			549.0541	22.87725		
DISPERSIVITY (cm)			0.270736			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			17.97645			
RESDIUAL SUM OF SQUARES =				0.000438		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		538.073	549.0541	560.0351		
DISPERSIVITY(cm)		0.243662	0.270736	0.303224		
Co(mV)		17.07763	17.97645	18.87528		
CRITICAL RSS VALUE =			0.000526			

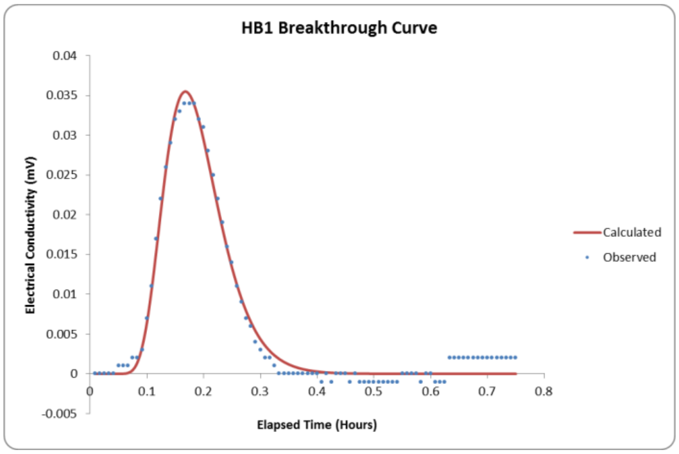
VelProbe output for 0605013_6cm_1625_finesand_15_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			513.0026	21.37511		
DISPERSIVITY (cm)			0.359732			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			21.07573			
RESDIUAL SUM OF SQUARES =				0.002106		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		487.3524	513.0026	543.7827		
DISPERSIVITY(cm)		0.29498	0.359732	0.438873		
Co(mV)		19.38967	21.07573	22.76179		
CRITICAL RSS VALUE =			0.002529			

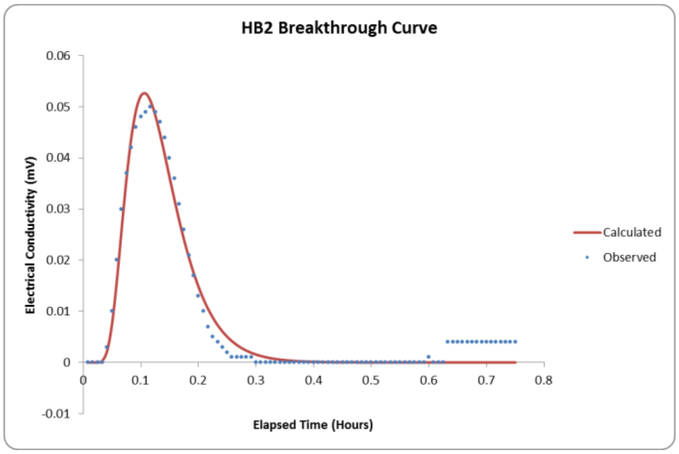
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.270736088	0.35973175	77.92226	48.128455	34.478492	549.0541	513.0026	309.7418	309.7418	0	.	1.36	0.84	0.60165	34.47199	309.7418	309.7418
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0605013_6cm_1657_finesand_15_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			538.3243	22.43018		
DISPERSIVITY (cm)			0.163141			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			9.861526			
RESDIUAL SUM OF SQUARES =				0.000122		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		532.941	538.3243	543.7075		
DISPERSIVITY(cm)		0.151721	0.163141	0.176192		
Co(mV)		9.56568	9.861526	10.15737		
CRITICAL RSS VALUE =			0.000138			

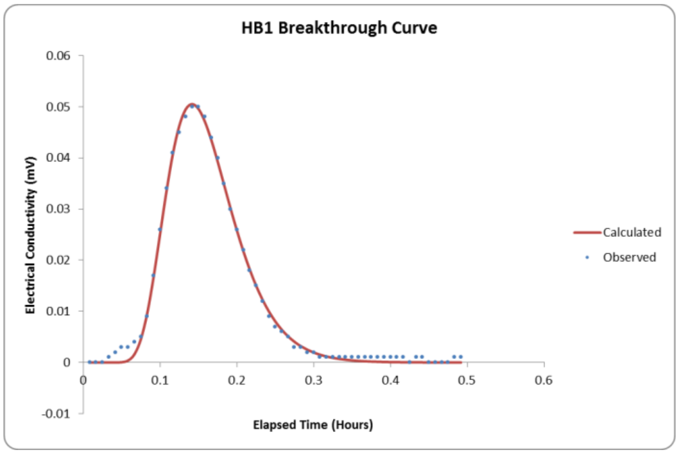
VelProbe output for 0605013_6cm_1657_finesand_15_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			487.5466	20.31444		
DISPERSIVITY (cm)			0.194663			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			12.0887			
RESDIUAL SUM OF SQUARES =				0.000485		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		477.7956	487.5466	497.2975		
DISPERSIVITY(cm)		0.177144	0.194663	0.218023		
Co(mV)		11.60515	12.0887	12.57224		
CRITICAL RSS VALUE =			0.000548			

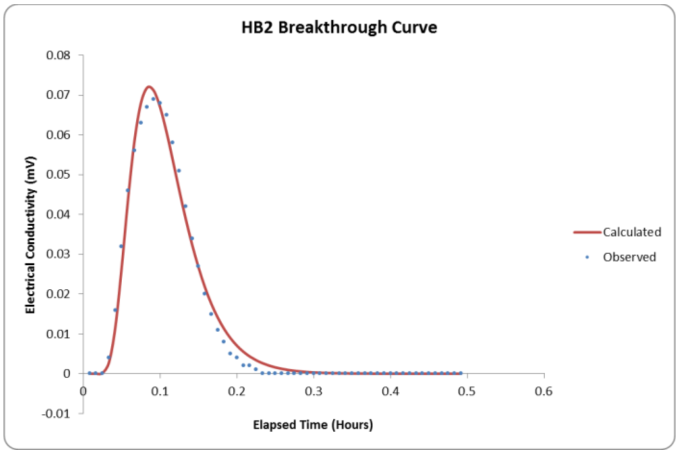
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.163140543	0.194663334	77.92226	48.128455	29.061325	538.3243	487.5466	313.9044	313.9044	-4.527E-15	.	1.36	0.84	0.50712	29.05584	313.9044	313.9044
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0606013_6cm_1345_finesand_30_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			632.7629	26.36512		
DISPERSIVITY (cm)			0.177845			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			14.58402			
RESDIUAL SUM OF SQUARES =				4.83E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		632.7629	632.7629	632.7629		
DISPERSIVITY(cm)		0.170731	0.177845	0.184958		
Co(mV)		14.29234	14.58402	14.72986		
CRITICAL RSS VALUE =			5.8E-05			

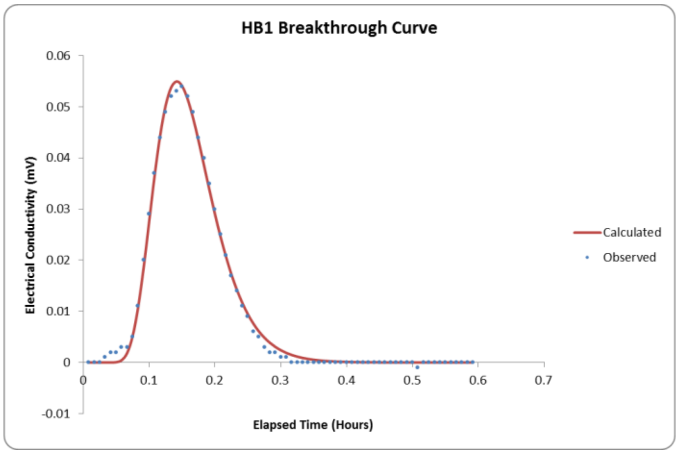
VelProbe output for 0606013_6cm_1345_finesand_30_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			601.7159	25.07149		
DISPERSIVITY (cm)			0.192016			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			16.41197			
RESDIUAL SUM OF SQUARES =				0.000284		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		589.6815	601.7159	613.7502		
DISPERSIVITY(cm)		0.176654	0.192016	0.209297		
Co(mV)		15.91961	16.41197	16.90432		
CRITICAL RSS VALUE =			0.000341			

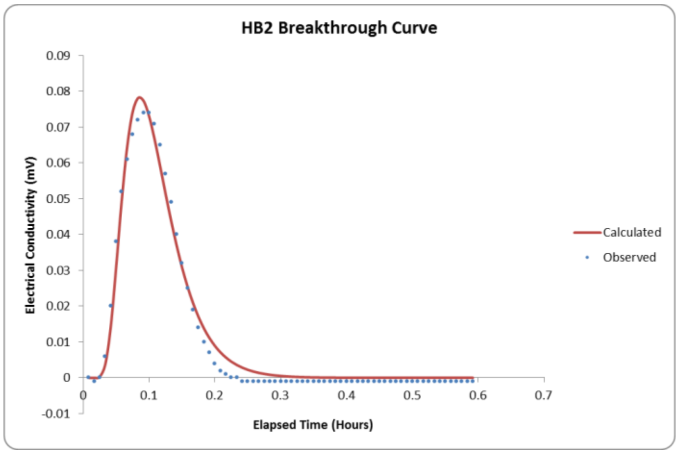
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.177844516	0.192015517	77.92226	48.128455	37.767131	632.7629	601.7159	351.5457	351.5457	-4.042E-15	.	1.36	0.84	0.659036	37.76001	351.5457	351.5457
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0606013_6cm_1418_finesand_30_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			628.7947	26.19978		
DISPERSIVITY (cm)			0.182961			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			16.07161			
RESDIUAL SUM OF SQUARES =				5.79E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		628.7947	628.7947	628.7947		
DISPERSIVITY(cm)		0.177472	0.182961	0.19028		
Co(mV)		15.9109	16.07161	16.23233		
CRITICAL RSS VALUE =			6.75E-05			

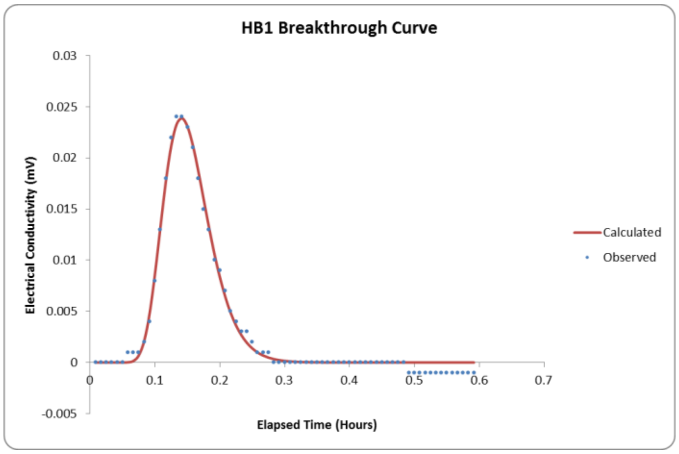
VelProbe output for 0606013_6cm_1418_finesand_30_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			595.9884	24.83285		
DISPERSIVITY (cm)			0.205248			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			18.30299			
RESDIUAL SUM OF SQUARES =				0.000556		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		584.0686	595.9884	607.9081		
DISPERSIVITY(cm)		0.186776	0.205248	0.225773		
Co(mV)		17.57087	18.30299	19.03511		
CRITICAL RSS VALUE =			0.000648			

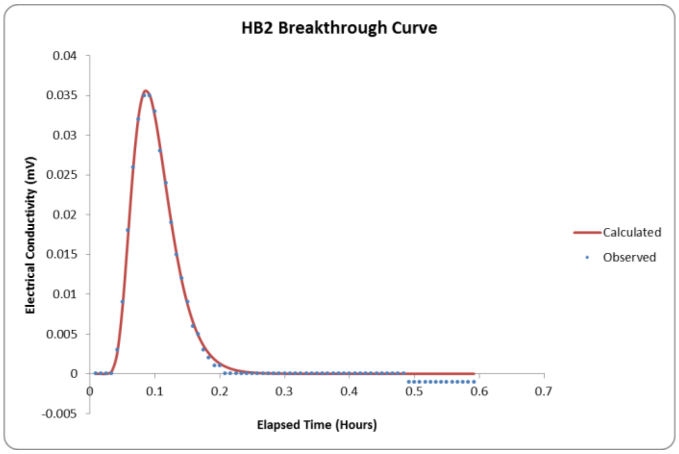
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.182961312	0.205247942	77.92226	48.128455	37.1438	628.7947	595.9884	350.2608	350.2608	4.057E-15	.	1.36	0.84	0.648159	37.13679	350.2608	350.2608
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0606013_6cm_1507_finesand_30_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES					
			cm/hr		
VELOCITY(cm/d)		656.3662	27.34859		
DISPERSIVITY (cm)		0.118468			
PULSE WIDTH (cm)		0.01			
RF		1			
Co (mV)		5.71031			
RESDIUAL SUM OF SQUARES =			2.24E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS					
					FIX
VELOCITY(cm/d)		400			
DISPERSIVITY (cm)		0.1			
PULSE WIDTH (cm)		0.01			Y
RF		1			Y
Co (mV)		2			
DISTANCE FROM SOURCE (cm)		4.08			Y
DIFFUSION COEFF (cm^2/sec)		0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS					
Parameter	Low	Optimized	High		
VELOCITY(cm/d)	656.3662	656.3662	662.9298		
DISPERSIVITY(cm)	0.11136	0.118468	0.125576		
Co(mV)	5.596104	5.71031	5.881619		
CRITICAL RSS VALUE =		2.61E-05			

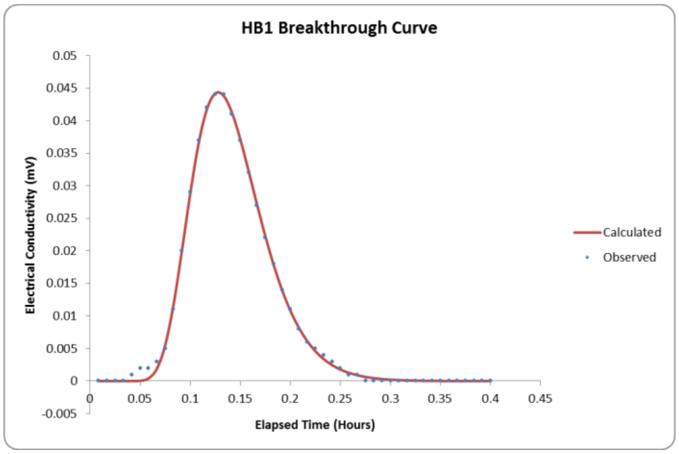
VelProbe output for 0606013_6cm_1507_finesand_30_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			628.2122	26.17551		
DISPERSIVITY (cm)			0.135293			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			6.981338			
RESDIUAL SUM OF SQUARES =				1.86E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		628.2122	628.2122	628.2122		
DISPERSIVITY(cm)		0.129882	0.135293	0.140705		
Co(mV)		6.911525	6.981338	7.051151		
CRITICAL RSS VALUE =			2.17E-05			

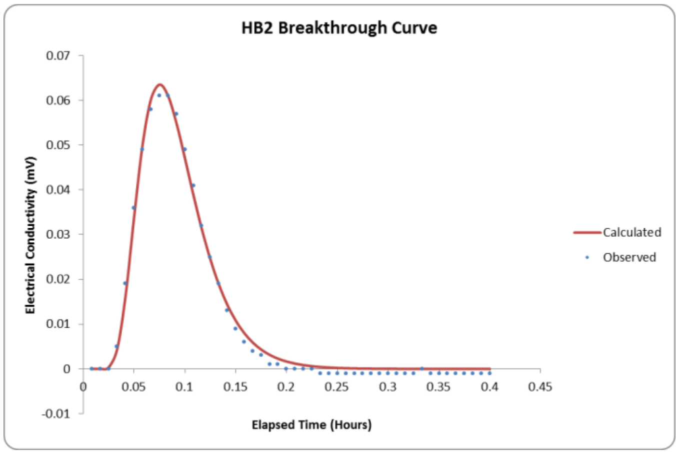
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.118467991	0.135293313	77.92226	48.128455	39.014636	656.3662	628.2122	362.8808	362.8808	7.832E-15	.	1.36	0.84	0.680805	39.00728	362.8808	362.8808
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0606013_6cm_1552_finesand_45_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			713.1325	29.71385		
DISPERSIVITY (cm)			0.143213			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			11.59544			
RESDIUAL SUM OF SQUARES =				1.19E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		713.1325	713.1325	713.1325		
DISPERSIVITY(cm)		0.138917	0.143213	0.14751		
Co(mV)		11.47948	11.59544	11.71139		
CRITICAL RSS VALUE =			1.5E-05			

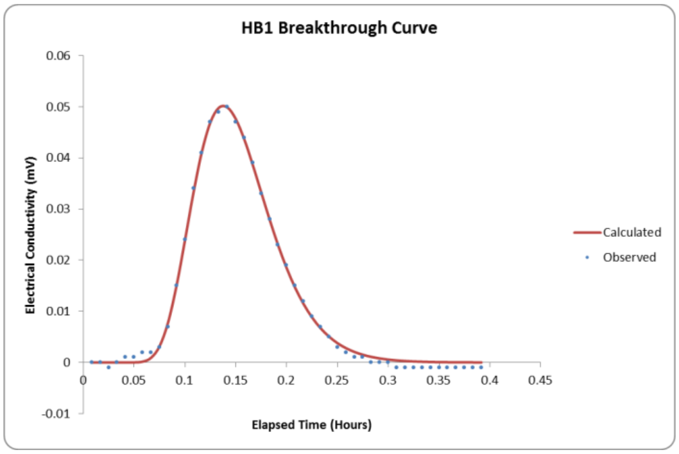
VelProbe output for 0606013_6cm_1552_finesand_45_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			702.5673	29.27364		
DISPERSIVITY (cm)			0.168026			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			13.66015			
RESDIUAL SUM OF SQUARES =				8.69E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		695.5416	702.5673	709.5929		
DISPERSIVITY(cm)		0.157945	0.168026	0.178108		
Co(mV)		13.38695	13.66015	14.06996		
CRITICAL RSS VALUE =			0.000109			

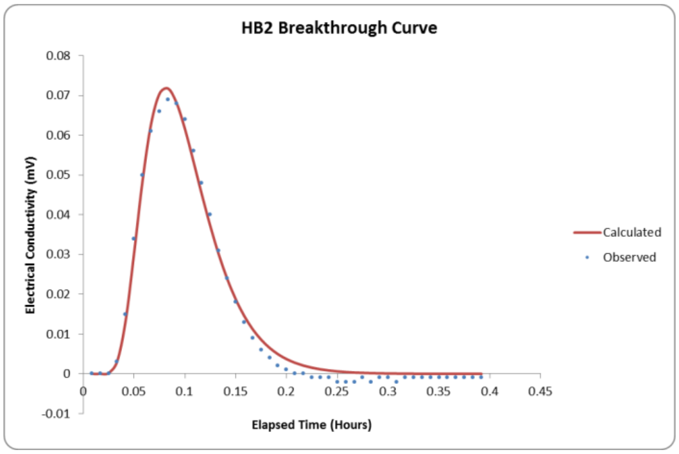
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.143213461	0.168026387	77.92226	48.128455	44.82065	713.1325	702.5673	387.8922	387.8922	0	.	1.36	0.84	0.78212	44.81219	387.8922	387.8922
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0606013_6cm_1617_finesand_45_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			662.9459	27.62275		
DISPERSIVITY (cm)			0.140747			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			13.0062			
RESDIUAL SUM OF SQUARES =				3.01E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		662.9459	662.9459	662.9459		
DISPERSIVITY(cm)		0.135117	0.140747	0.146377		
Co(mV)		12.87614	13.0062	13.13626		
CRITICAL RSS VALUE =			3.78E-05			

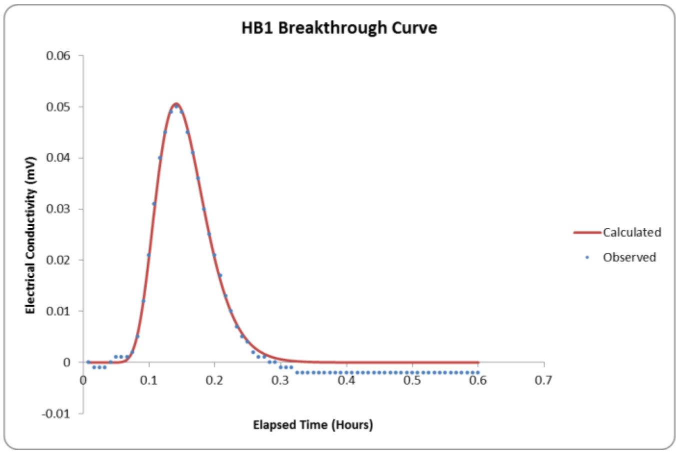
VelProbe output for 0606013_6cm_1617_finesand_45_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			647.3252	26.97188		
DISPERSIVITY (cm)			0.174257			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			15.70068			
RESDIUAL SUM OF SQUARES =				0.000184		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		640.852	647.3252	653.7985		
DISPERSIVITY(cm)		0.160316	0.174257	0.188197		
Co(mV)		15.22966	15.70068	16.1717		
CRITICAL RSS VALUE =			0.000231			

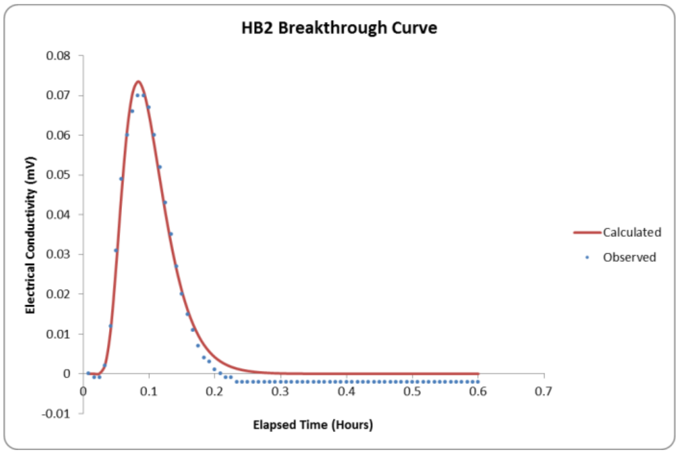
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.140746891	0.17425657	77.92226	48.128455	42.992329	662.9459	647.3252	362.0387	362.0387	0	.	1.36	0.84	0.750216	42.98422	362.0387	362.0387
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0606013_6cm_1644_finesand_45_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			650.4878	27.10366		
DISPERSIVITY (cm)			0.134575			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			12.8408			
RESDIUAL SUM OF SQUARES =				0.000163		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		643.9829	650.4878	656.9927		
DISPERSIVITY(cm)		0.125155	0.134575	0.145341		
Co(mV)		12.45557	12.8408	13.22602		
CRITICAL RSS VALUE =			0.00019			

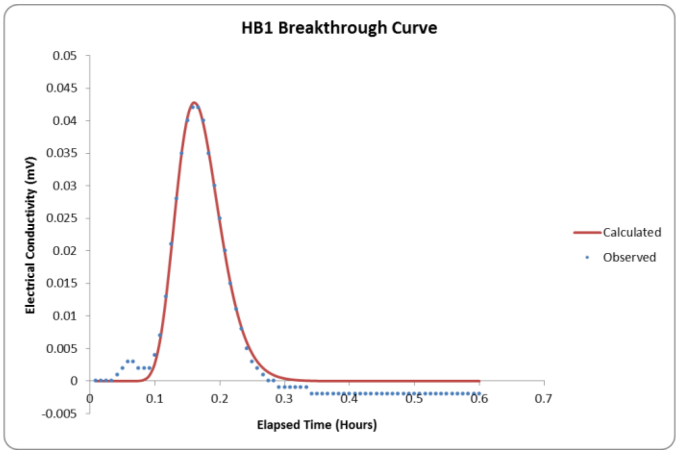
VelProbe output for 0606013_6cm_1644_finesand_45_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			633.2116	26.38382		
DISPERSIVITY (cm)			0.168863			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			15.84814			
RESDIUAL SUM OF SQUARES =				0.00037		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		620.5474	633.2116	645.8758		
DISPERSIVITY(cm)		0.155354	0.168863	0.184061		
Co(mV)		15.3727	15.84814	16.48207		
CRITICAL RSS VALUE =			0.00043			

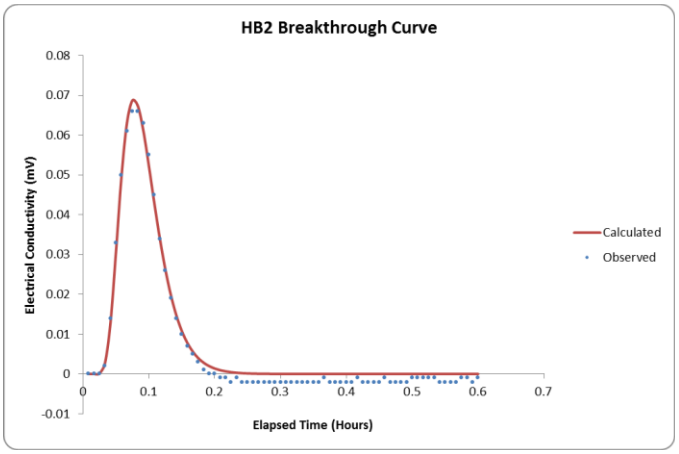
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.134574797	0.168863387	77.92226	48.128455	42.369638	650.4878	633.2116	355.8033	355.8033	0	.	1.36	0.84	0.73935	42.36164	355.8033	355.8033
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0606013_6cm_1729_finesand_75_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			584.528	24.35533		
DISPERSIVITY (cm)			0.085787			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			8.791355			
RESDIUAL SUM OF SQUARES =				0.000181		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		578.6827	584.528	590.3732		
DISPERSIVITY(cm)		0.077208	0.085787	0.095224		
Co(mV)		8.439701	8.791355	9.143009		
CRITICAL RSS VALUE =			0.000211			

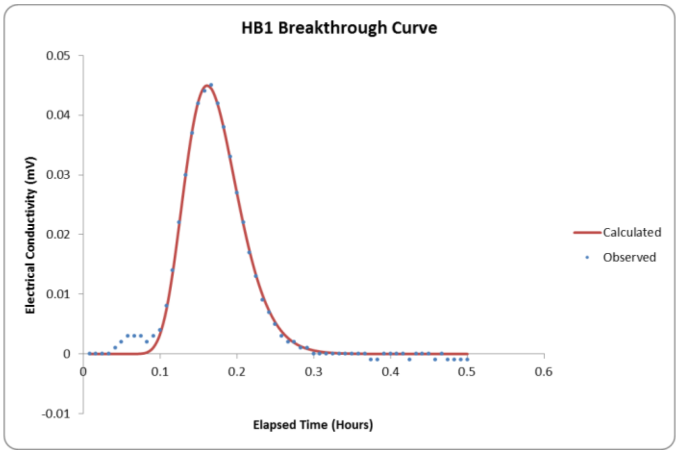
VelProbe output for 0606013_6cm_1729_finesand_75_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			693.5824	28.89927		
DISPERSIVITY (cm)			0.148655			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			14.04914			
RESDIUAL SUM OF SQUARES =				0.00021		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		686.6466	693.5824	700.5182		
DISPERSIVITY(cm)		0.138249	0.148655	0.160547		
Co(mV)		13.62766	14.04914	14.47061		
CRITICAL RSS VALUE =			0.000245			

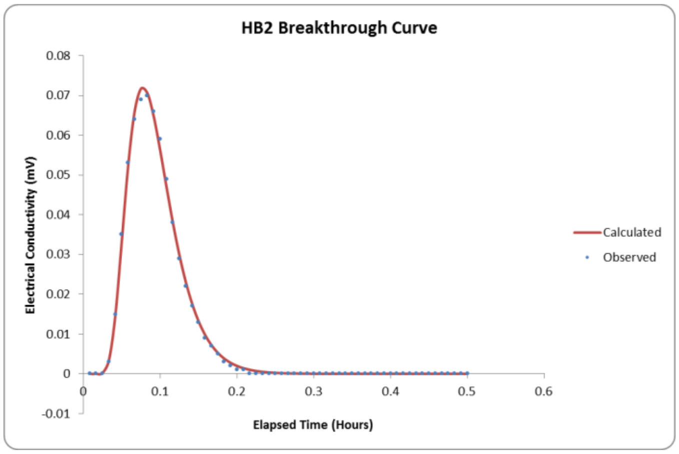
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.085787195	0.148654827	77.92226	48.128455	83.551593	584.528	693.5824	374.7422	374.7422	0	.	1.36	0.84	1.457975	83.53583	374.7422	374.7422
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0606013_6cm_1814_finesand_75_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			580.2725	24.17802		
DISPERSIVITY (cm)			0.091206			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			9.513616			
RESDIUAL SUM OF SQUARES =				5.14E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		580.2725	580.2725	580.2725		
DISPERSIVITY(cm)		0.086646	0.091206	0.096678		
Co(mV)		9.323344	9.513616	9.703889		
CRITICAL RSS VALUE =			6.16E-05			

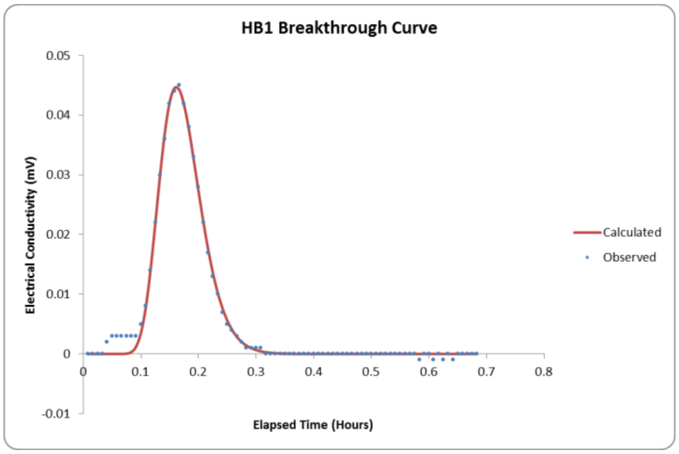
VelProbe output for 0606013_6cm_1814_finesand_75_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			683.7554	28.48981		
DISPERSIVITY (cm)			0.159237			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			15.13451			
RESDIUAL SUM OF SQUARES =				3.71E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		683.7554	683.7554	683.7554		
DISPERSIVITY(cm)		0.15446	0.159237	0.164014		
Co(mV)		14.98316	15.13451	15.28585		
CRITICAL RSS VALUE =			4.44E-05			

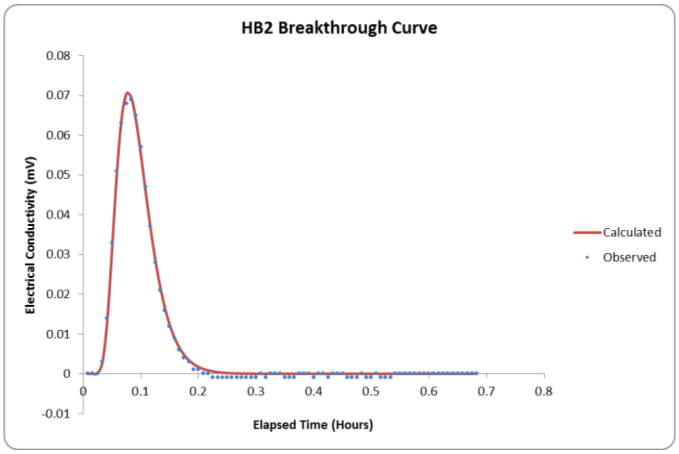
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.091205921	0.159237362	77.92226	48.128455	82.290852	580.2725	683.7554	366.9607	366.9607	-3.873E-15	.	1.36	0.84	1.435975	82.27533	366.9607	366.9607
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0606013_6cm_1847_finesand_75_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			578.9989	24.12495		
DISPERSIVITY (cm)			0.09337			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			9.569055			
RESDIUAL SUM OF SQUARES =				6.18E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		578.9989	578.9989	578.9989		
DISPERSIVITY(cm)		0.088702	0.09337	0.098039		
Co(mV)		9.377674	9.569055	9.760436		
CRITICAL RSS VALUE =			7.05E-05			

VelProbe output for 0606013_6cm_1847_finesand_75_0.5gL_0.5 – Half Bridge 2



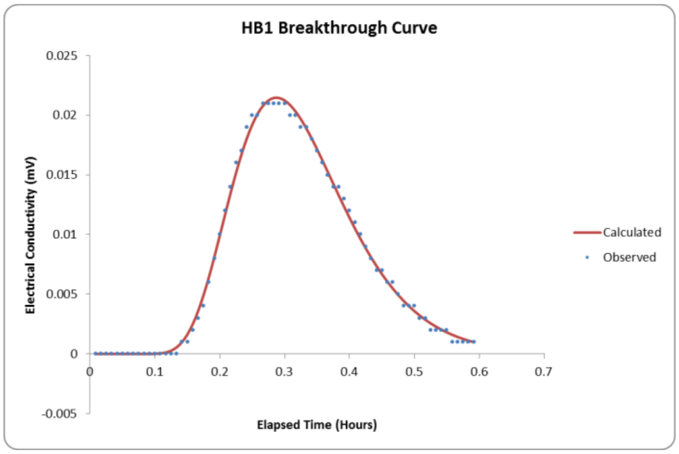
OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			686.3489	28.59787		
DISPERSIVITY (cm)			0.153437			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			14.64763			
RESDIUAL SUM OF SQUARES =				5.57E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		686.3489	686.3489	686.3489		
DISPERSIVITY(cm)		0.148834	0.153437	0.15804		
Co(mV)		14.50115	14.64763	14.79411		
CRITICAL RSS VALUE =			6.36E-05			

Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.093370249	0.153436757	77.92226	48.128455	83.375737	578.9989	686.3489	370.4751	370.4751	0	.	1.36	0.84	1.454907	83.36001	370.4751	370.4751
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VELPROBE OUTPUT

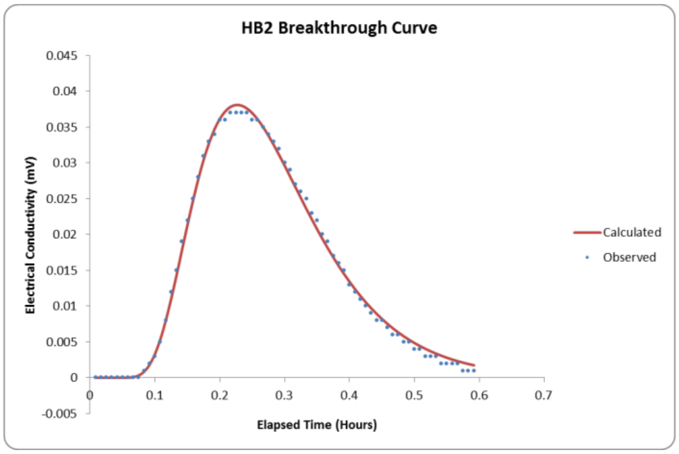
4 cm PVP Data for Fine Sand

VelProbe output for 0608013_4cm_1327_finesand_15_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			222.2734	9.261392		
DISPERSIVITY (cm)			0.123728			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			4.365845			
RESDIUAL SUM OF SQUARES =				1.1E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		222.2734	222.2734	222.2734		
DISPERSIVITY(cm)		0.120016	0.123728	0.12744		
Co(mV)		4.322186	4.365845	4.409503		
CRITICAL RSS VALUE =			1.28E-05			

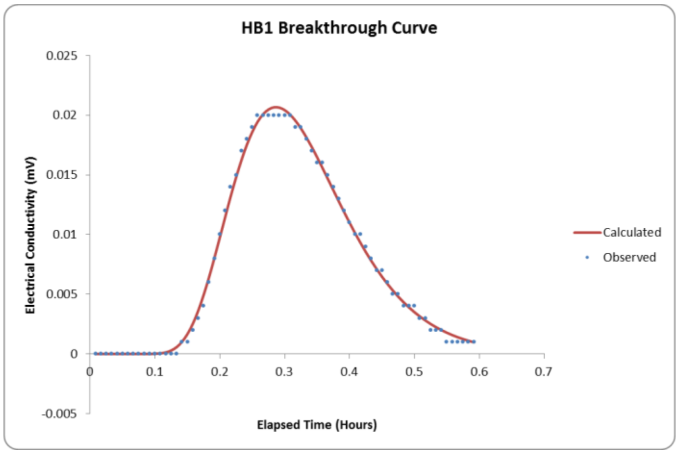
VelProbe output for 0608013_4cm_1327_finesand_15_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			167.7317	6.988821		
DISPERSIVITY (cm)			0.138401			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			6.325333			
RESDIUAL SUM OF SQUARES =				3.13E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.85			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		167.7317	167.7317	167.7317		
DISPERSIVITY(cm)		0.134249	0.138401	0.141169		
Co(mV)		6.262079	6.325333	6.388586		
CRITICAL RSS VALUE =			3.64E-05			

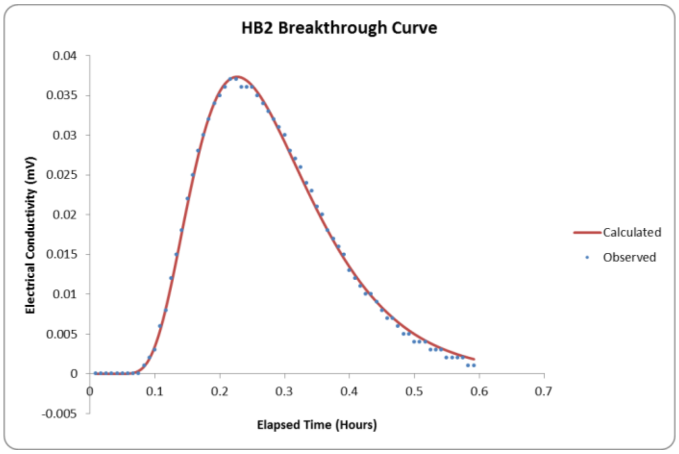
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.123727953	0.138401153	79.883539	50.960189	5.0397887	222.2734	167.7317	170.7196	170.7196	-4.162E-15	.	1.394231	0.889423	0.087944	5.038838	170.7196	170.7196
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0608013_4cm_1406_finesand_15_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			222.4517	9.268823		
DISPERSIVITY (cm)			0.125473			
PULSE WIDTH (cm)			0.017016			
RF			1			
Co (mV)			2.487992			
RESDIUAL SUM OF SQUARES =				1.04E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		222.4517	222.4517	222.4517		
DISPERSIVITY(cm)		0.121709	0.125473	0.130492		
PULSE WIDTH (cm)		0.016846	0.017016	0.017186		
Co(mV)		2.463112	2.487992	2.512872		
CRITICAL RSS VALUE =			1.27E-05			

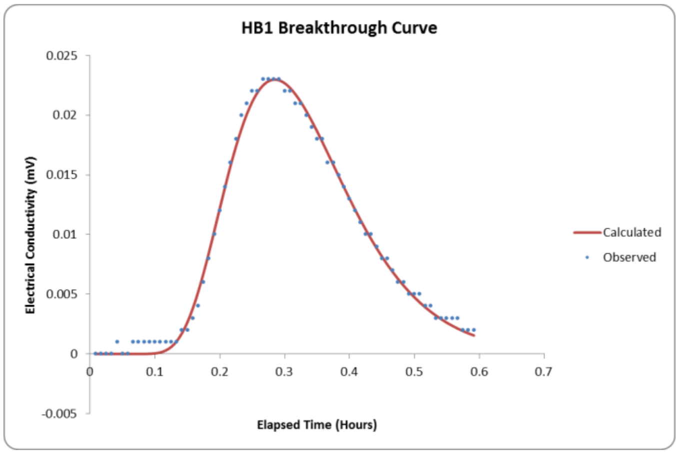
VelProbe output for 0608013_4cm_1406_finesand_15_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			162.7074	6.779474		
DISPERSIVITY (cm)			0.137827			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			6.089307			
RESDIUAL SUM OF SQUARES =				2.05E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		162.7074	162.7074	162.7074		
DISPERSIVITY(cm)		0.13507	0.137827	0.140583		
Co(mV)		6.028414	6.089307	6.150201		
CRITICAL RSS VALUE =			2.39E-05			

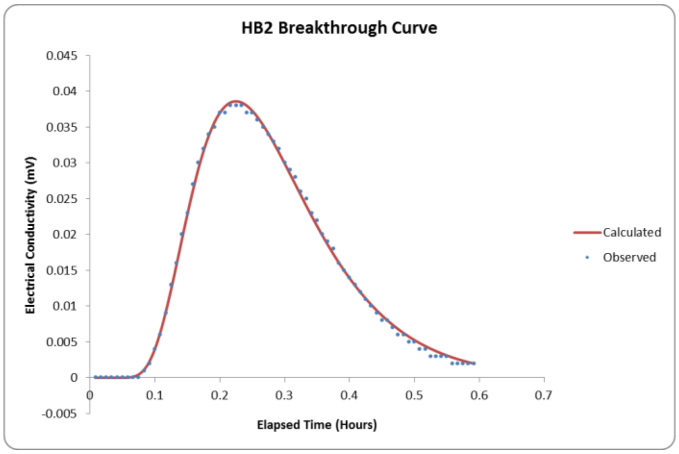
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.125472755	0.137826943	79.883539	49.582886	4.1110115	222.4517	162.7074	173.6963	173.6963	-8.181E-15	.	1.394231	0.865385	0.071737	4.110236	173.6963	173.6963
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0608013_4cm_1504_finesand_15_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			220.9102	9.204592		
DISPERSIVITY (cm)			0.143422			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			5.00254			
RESDIUAL SUM OF SQUARES =				2.06E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		220.9102	220.9102	220.9102		
DISPERSIVITY(cm)		0.139119	0.143422	0.149159		
Co(mV)		4.952515	5.00254	5.052565		
CRITICAL RSS VALUE =			2.4E-05			

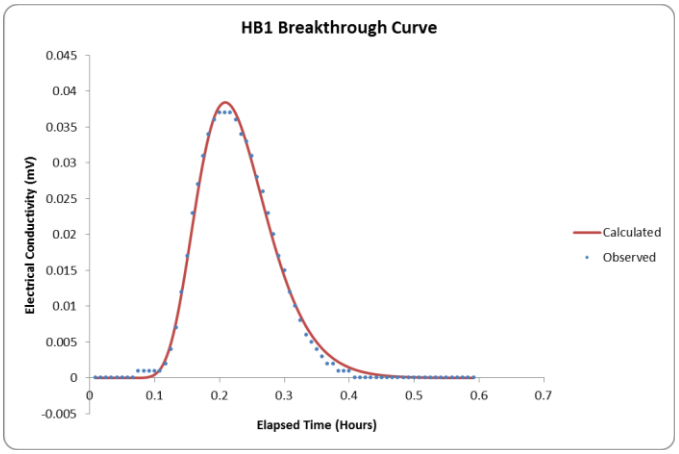
VelProbe output for 0608013_4cm_1504_finesand_15_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			163.2491	6.802045		
DISPERSIVITY (cm)			0.141971			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			6.375514			
RESDIUAL SUM OF SQUARES =				1.74E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		163.2491	163.2491	163.2491		
DISPERSIVITY(cm)		0.139132	0.141971	0.144811		
Co(mV)		6.375514	6.375514	6.439269		
CRITICAL RSS VALUE =			2.02E-05			

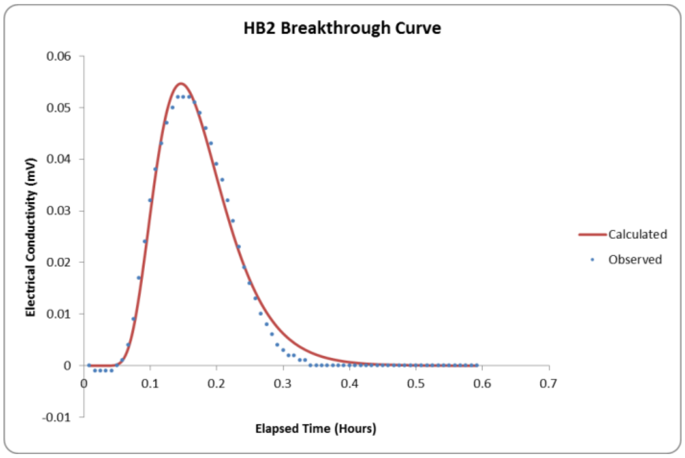
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.143422124	0.14197141	79.883539	49.582886	4.8827797	220.9102	163.2491	170.1396	170.1396	-4.176E-15	.	1.394231	0.865385	0.085205	4.881859	170.1396	170.1396
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0608013_4cm_1601_finesand_30_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			312.2481	13.01034		
DISPERSIVITY (cm)			0.094087			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			6.892274			
RESDIUAL SUM OF SQUARES =				3.7E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		312.2481	312.2481	312.2481		
DISPERSIVITY(cm)		0.090324	0.094087	0.097851		
Co(mV)		6.823352	6.892274	6.961197		
CRITICAL RSS VALUE =			4.31E-05			

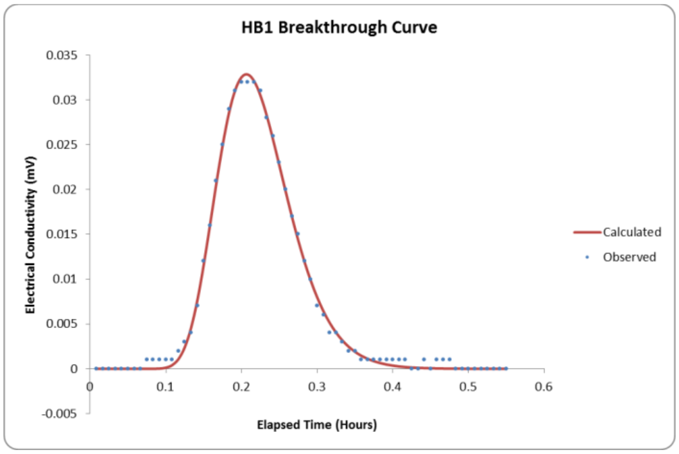
VelProbe output for 0608013_4cm_1601_finesand_30_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			261.9815	10.9159		
DISPERSIVITY (cm)			0.106262			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			7.975187			
RESDIUAL SUM OF SQUARES =				0.000196		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		259.3617	261.9815	264.6013		
DISPERSIVITY(cm)		0.099886	0.106262	0.1137		
Co(mV)		7.735931	7.975187	8.214442		
CRITICAL RSS VALUE =			0.000228			

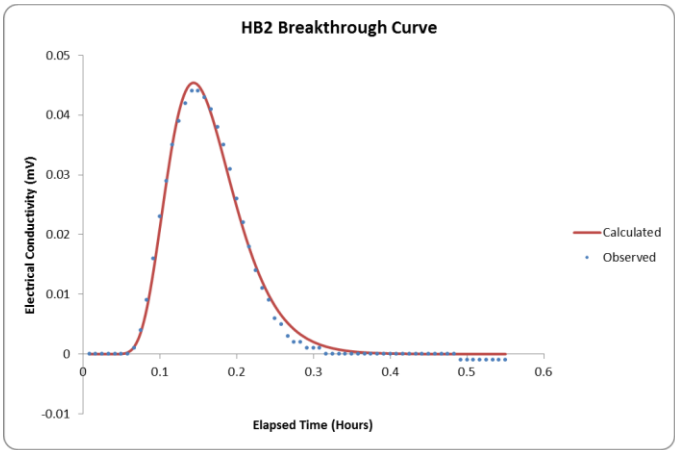
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.094087438	0.106261637	79.883539	49.582886	17.3434	312.2481	261.9815	201.4939	201.4939	0	.	1.394231	0.865385	0.302642	17.34013	201.4939	201.4939
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0608013_4cm_1644_finesand_30_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			320.9618	13.37341		
DISPERSIVITY (cm)			0.071091			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			5.163074			
RESDIUAL SUM OF SQUARES =				1.73E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		320.9618	320.9618	320.9618		
DISPERSIVITY(cm)		0.068959	0.071091	0.073224		
Co(mV)		5.111443	5.163074	5.214705		
CRITICAL RSS VALUE =			2.04E-05			

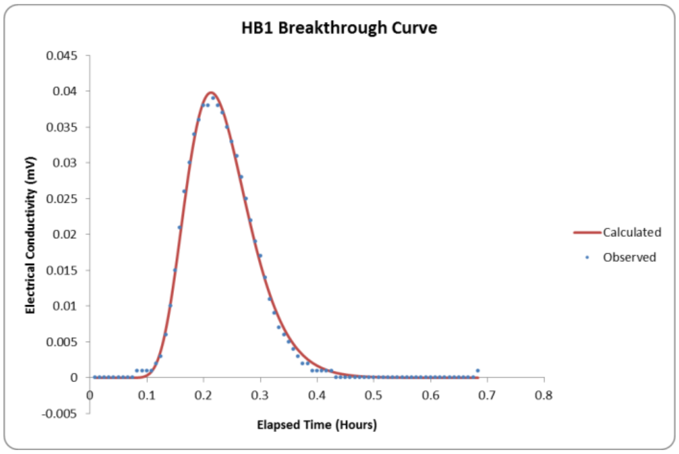
VelProbe output for 0608013_4cm_1644_finesand_30_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			274.6335	11.44306		
DISPERSIVITY (cm)			0.078322			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			5.785715			
RESDIUAL SUM OF SQUARES =				7.07E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		271.8872	274.6335	277.3799		
DISPERSIVITY(cm)		0.074406	0.078322	0.083021		
Co(mV)		5.670001	5.785715	5.90143		
CRITICAL RSS VALUE =			8.33E-05			

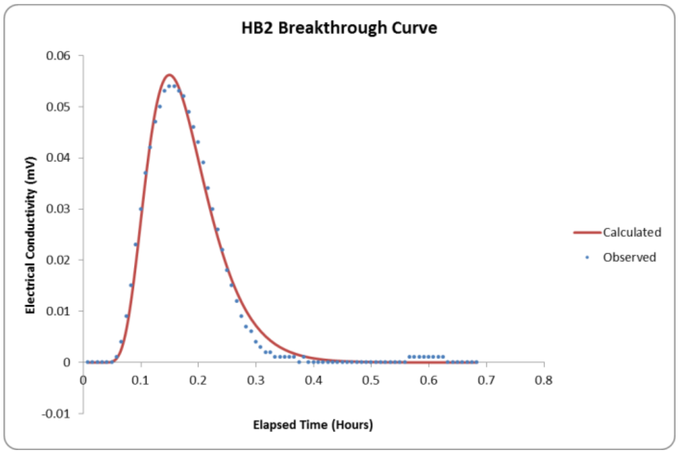
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.071091315	0.078322146	79.883539	49.582886	19.865721	320.9618	274.6335	201.6131	201.6131	-3.524E-15	.	1.394231	0.865385	0.346657	19.86197	201.6131	201.6131
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0608013_4cm_1716_finesand_30_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			306.4457	12.76857		
DISPERSIVITY (cm)			0.091181			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			7.040935			
RESDIUAL SUM OF SQUARES =				3.01E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		306.4457	306.4457	306.4457		
DISPERSIVITY(cm)		0.088446	0.091181	0.093916		
Co(mV)		6.970526	7.040935	7.111345		
CRITICAL RSS VALUE =			3.43E-05			

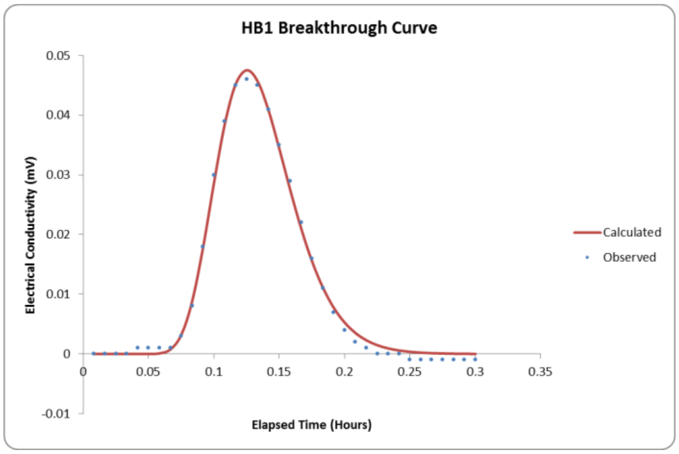
VelProbe output for 0608013_4cm_1716_finesand_30_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES					
			cm/hr		
VELOCITY(cm/d)		256.3597	10.68165		
DISPERSIVITY (cm)		0.104845			
PULSE WIDTH (cm)		0.01			
RF		1			
Co (mV)		8.155162			
RESDIUAL SUM OF SQUARES =			0.000197		
INITIAL GUESSES AND INPUT OF PARAMETERS					
					FIX
VELOCITY(cm/d)		300			
DISPERSIVITY (cm)		0.1			
PULSE WIDTH (cm)		0.01			Y
RF		1			Y
Co (mV)		2			
DISTANCE FROM SOURCE (cm)		1.8			Y
DIFFUSION COEFF (cm^2/sec)		0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS					
Parameter	Low	Optimized	High		
VELOCITY(cm/d)	253.7961	256.3597	258.9233		
DISPERSIVITY(cm)	0.099603	0.104845	0.111136		
Co(mV)	7.992059	8.155162	8.318265		
CRITICAL RSS VALUE =		0.000225			

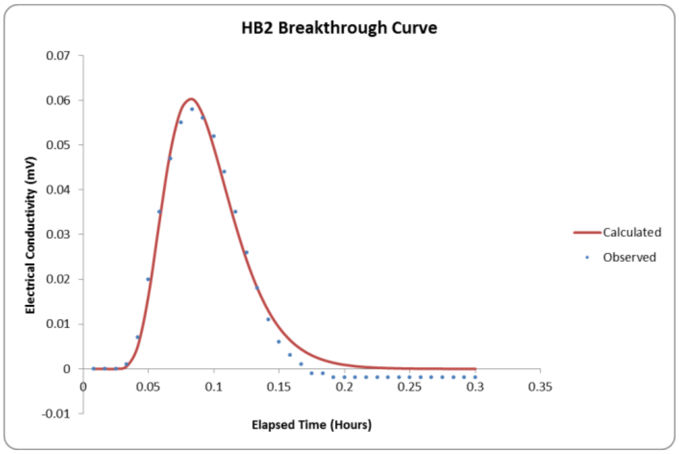
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.091181055	0.10484537	79.883539	49.582886	16.982183	306.4457	256.3597	198.5576	198.5576	-7.157E-15	.	1.394231	0.865385	0.296339	16.97898	198.5576	198.5576
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0609013_4cm_1403_finesand_45_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			528.6043	22.02518		
DISPERSIVITY (cm)			0.072116			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			7.518391			
RESDIUAL SUM OF SQUARES =				3.07E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		528.6043	528.6043	528.6043		
DISPERSIVITY(cm)		0.067789	0.072116	0.076443		
Co(mV)		7.368024	7.518391	7.668759		
CRITICAL RSS VALUE =			4.13E-05			

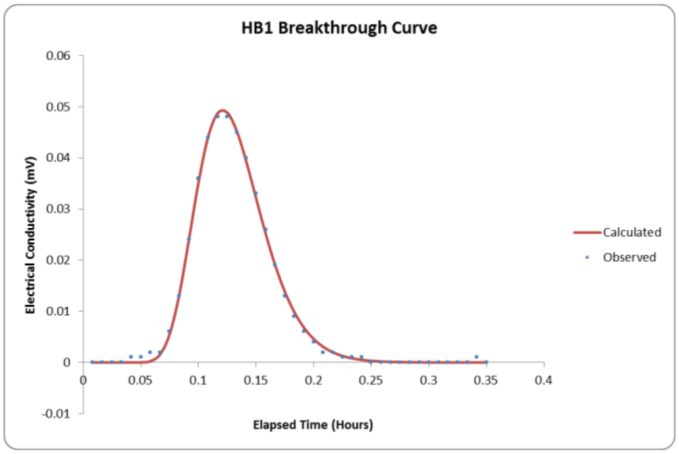
VelProbe output for 0609013_4cm_1403_finesand_45_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			477.7019	19.90425		
DISPERSIVITY (cm)			0.08656			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			8.032679			
RESDIUAL SUM OF SQUARES =				0.000204		
INITIAL GUESSES AND INPUT OF PARAMETERS						
					FIX	
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01		Y	
RF			1		Y	
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8		Y	
DIFFUSION COEFF (cm^2/sec)			0.000001		Y	
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		468.1479	477.7019	487.256		
DISPERSIVITY(cm)		0.076173	0.08656	0.098678		
Co(mV)		7.631045	8.032679	8.434313		
CRITICAL RSS VALUE =			0.000275			

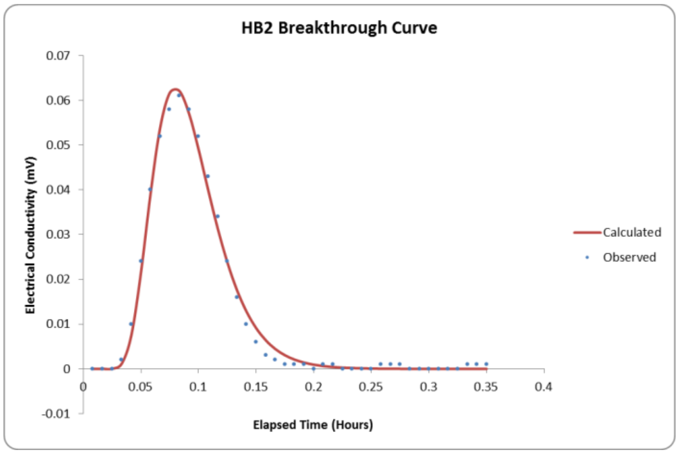
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.072116212	0.086559681	79.883539	49.582886	27.906314	528.6043	477.7019	309.8717	309.8717	-4.586E-15	.	1.394231	0.865385	0.486965	27.90105	309.8717	309.8717
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0609013_4cm_1422_finesand_45_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			545.4021	22.72509		
DISPERSIVITY (cm)			0.077011			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			8.047151			
RESDIUAL SUM OF SQUARES =				1.46E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		545.4021	545.4021	545.4021		
DISPERSIVITY(cm)		0.074701	0.077011	0.080092		
Co(mV)		7.96668	8.047151	8.127623		
CRITICAL RSS VALUE =			1.88E-05			

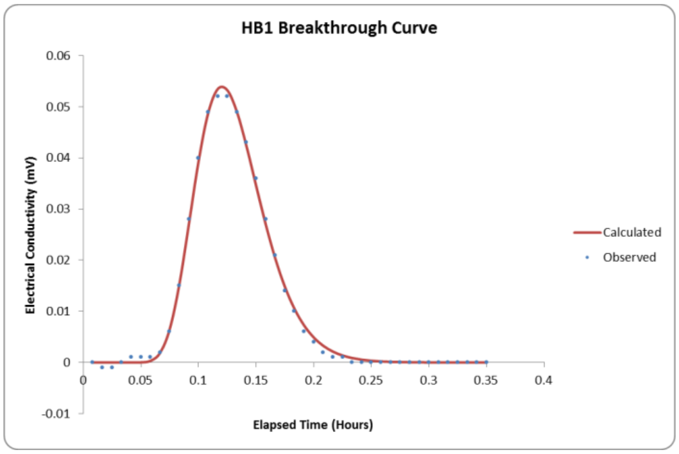
VelProbe output for 0609013_4cm_1422_finesand_45_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			487.9579	20.33158		
DISPERSIVITY (cm)			0.092152			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			8.586069			
RESDIUAL SUM OF SQUARES =				0.000108		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		483.0783	487.9579	492.8375		
DISPERSIVITY(cm)		0.085701	0.092152	0.100445		
Co(mV)		8.328487	8.586069	8.843651		
CRITICAL RSS VALUE =			0.00014			

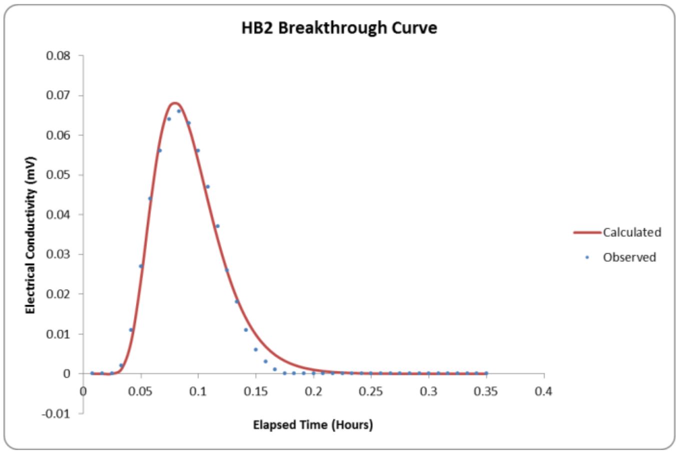
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.077011155	0.092151585	79.883539	49.582886	26.311266	545.4021	487.9579	323.5102	323.5102	-4.393E-15	.	1.394231	0.865385	0.459132	26.3063	323.5102	323.5102
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0609013_4cm_1442_finesand_45_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			547.6602	22.81918		
DISPERSIVITY (cm)			0.077902			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			8.84504			
RESDIUAL SUM OF SQUARES =				2.14E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		547.6602	547.6602	547.6602		
DISPERSIVITY(cm)		0.074786	0.077902	0.081018		
Co(mV)		8.75659	8.84504	8.93349		
CRITICAL RSS VALUE =			2.77E-05			

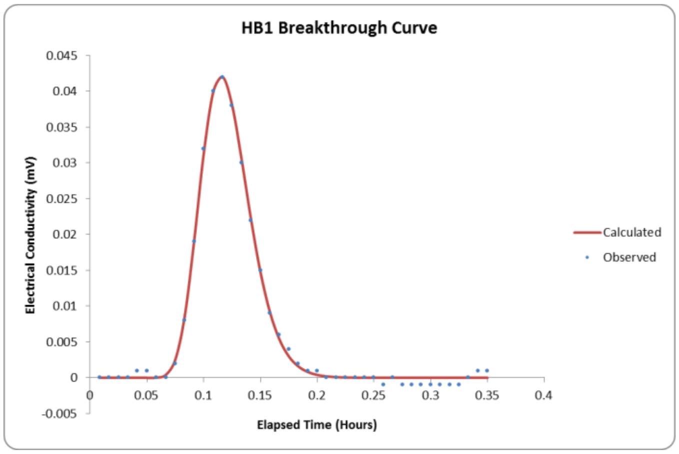
VelProbe output for 0609013_4cm_1442_finesand_45_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			489.1522	20.38134		
DISPERSIVITY (cm)			0.092389			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			9.35666			
RESDIUAL SUM OF SQUARES =				0.000146		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		484.2607	489.1522	494.0438		
DISPERSIVITY(cm)		0.084998	0.092389	0.100704		
Co(mV)		9.07596	9.35666	9.730927		
CRITICAL RSS VALUE =			0.000188			

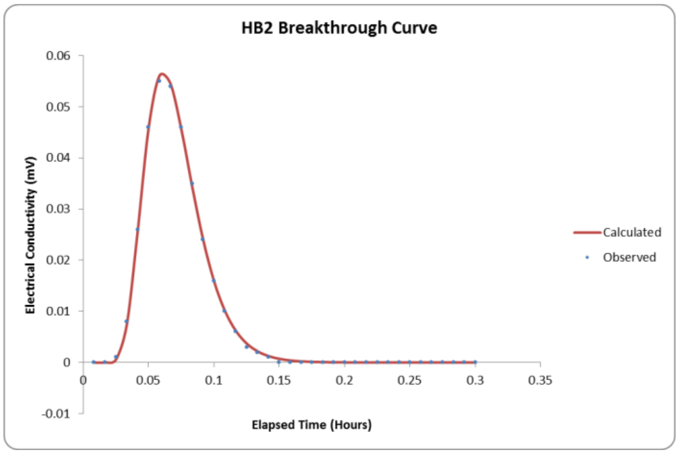
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.077901941	0.092389376	79.883539	49.582886	26.048519	547.6602	489.1522	325.5098	325.5098	0	.	1.394231	0.865385	0.454547	26.04361	325.5098	325.5098
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0609013_4cm_1516_finesand_75_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			584.6137	24.3589		
DISPERSIVITY (cm)			0.048077			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			5.488313			
RESDIUAL SUM OF SQUARES =				1.59E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		584.6137	584.6137	584.6137		
DISPERSIVITY(cm)		0.045673	0.048077	0.050481		
Co(mV)		5.378547	5.488313	5.598079		
CRITICAL RSS VALUE =			2.06E-05			

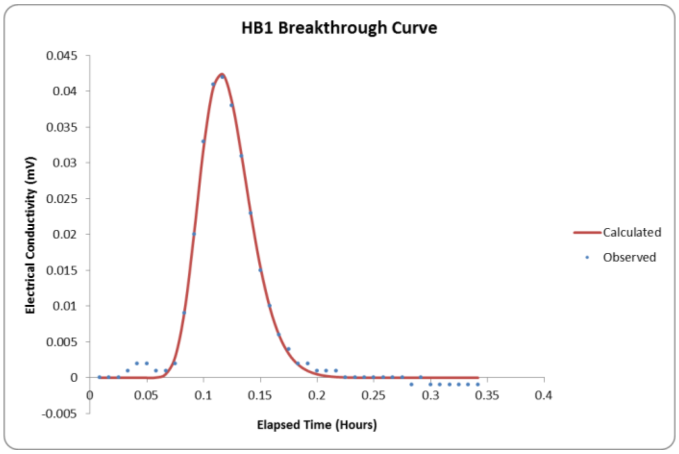
VelProbe output for 0609013_4cm_1516_finesand_75_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			641.837	26.74321		
DISPERSIVITY (cm)			0.084661			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			7.474726			
RESDIUAL SUM OF SQUARES =				0.002861		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		584.0717	641.837	712.4391		
DISPERSIVITY(cm)		0.04995	0.084661	0.158317		
Co(mV)		5.606045	7.474726	9.268661		
CRITICAL RSS VALUE =			0.003694			

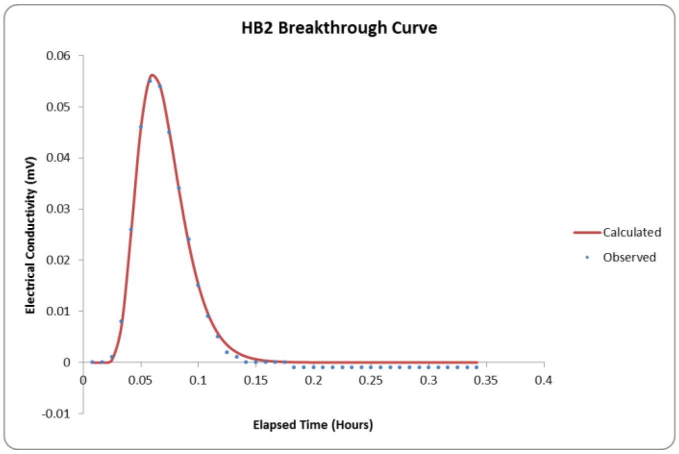
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.048077241	0.084661364	79.883539	49.582886	66.709505	584.6137	641.837	331.2673	331.2673	8.58E-15	.	1.394231	0.865385	1.164081	66.69692	331.2673	331.2673
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0609013_4cm_1534_finesand_75_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			584.6453	24.36022		
DISPERSIVITY (cm)			0.050299			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			5.661194			
RESDIUAL SUM OF SQUARES =				2.33E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		584.6453	584.6453	584.6453		
DISPERSIVITY(cm)		0.047281	0.050299	0.053317		
Co(mV)		5.54797	5.661194	5.774418		
CRITICAL RSS VALUE =			3.02E-05			

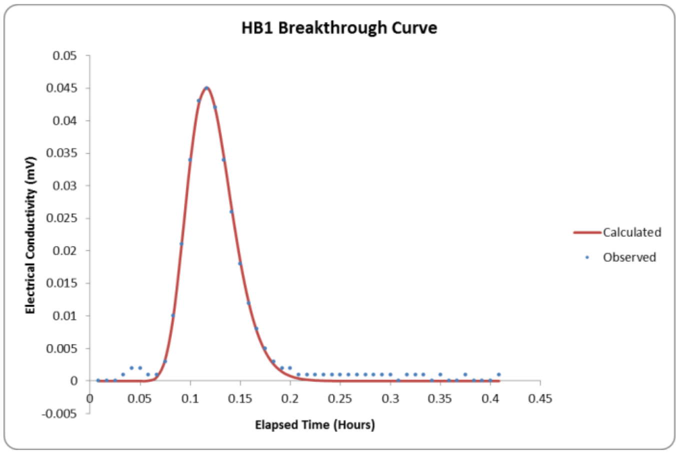
VelProbe output for 0609013_4cm_1534_finesand_75_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			645.7756	26.90732		
DISPERSIVITY (cm)			0.082983			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			7.367534			
RESDIUAL SUM OF SQUARES =				2.84E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		639.3179	645.7756	652.2334		
DISPERSIVITY(cm)		0.078834	0.082983	0.087962		
Co(mV)		7.220184	7.367534	7.514885		
CRITICAL RSS VALUE =			3.69E-05			

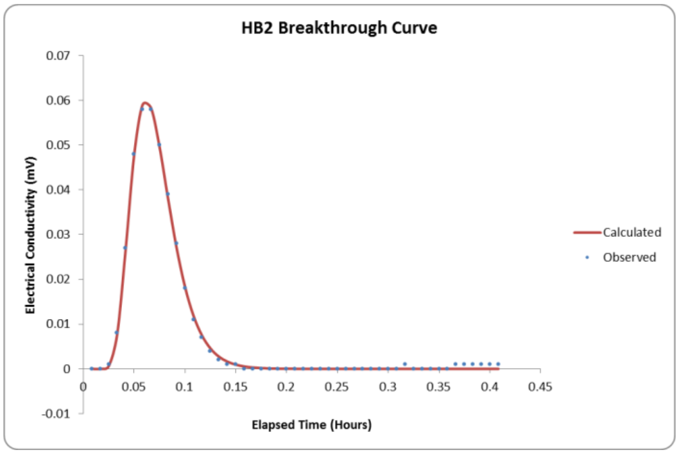
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.050298942	0.082983259	79.883539	49.582886	67.978183	584.6453	645.7756	333.5737	333.5737	4.26E-15	.	1.394231	0.865385	1.186219	67.96536	333.5737	333.5737
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0609013_4cm_1600_finesand_75_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			578.8852	24.12022		
DISPERSIVITY (cm)			0.053365			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			6.180514			
RESDIUAL SUM OF SQUARES =				3.05E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.9			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		578.8852	578.8852	578.8852		
DISPERSIVITY(cm)		0.050163	0.053365	0.056567		
Co(mV)		6.056903	6.180514	6.304124		
CRITICAL RSS VALUE =			3.8E-05			

VelProbe output for 0609013_4cm_1600_finesand_75_0.5gL_0.1 – Half Bridge 2



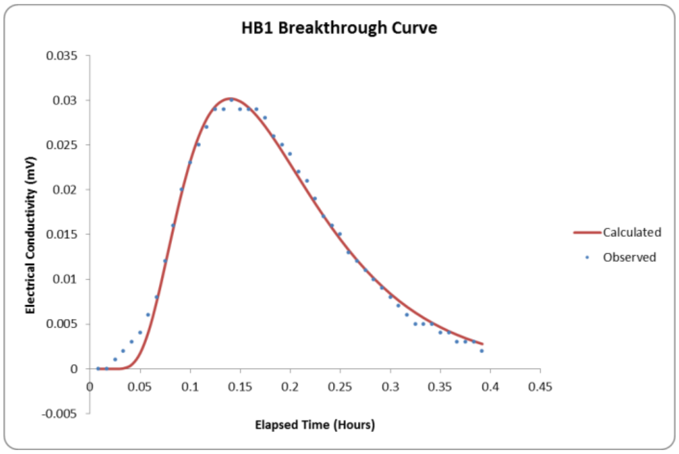
OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			633.5762	26.39901		
DISPERSIVITY (cm)			0.086785			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			8.00236			
RESDIUAL SUM OF SQUARES =				1.32E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.8			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		633.5762	633.5762	633.5762		
DISPERSIVITY(cm)		0.084181	0.086785	0.089389		
Co(mV)		7.922337	8.00236	8.082384		
CRITICAL RSS VALUE =			1.64E-05			

Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.05336535	0.086785025	79.883539	49.582886	66.055815	578.8852	633.5762	326.9281	326.9281	-4.347E-15	.	1.394231	0.865385	1.152674	66.04335	326.9281	326.9281
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VELPROBE OUTPUT

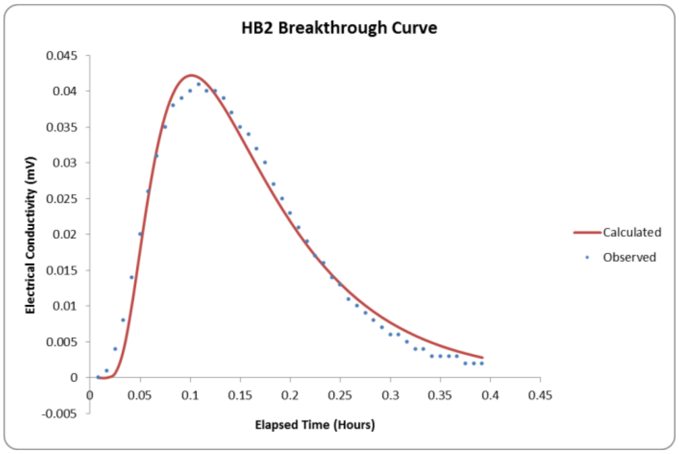
2 cm PVP Data for Fine Sand

VelProbe output for 0612013_2cm_1231_finesand_15_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			189.5525	7.898023		
DISPERSIVITY (cm)			0.151537			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			4.374566			
RESDIUAL SUM OF SQUARES =				3.48E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		187.657	189.5525	191.4481		
DISPERSIVITY(cm)		0.14396	0.151537	0.160629		
Co(mV)		4.287075	4.374566	4.462058		
CRITICAL RSS VALUE =			4.38E-05			

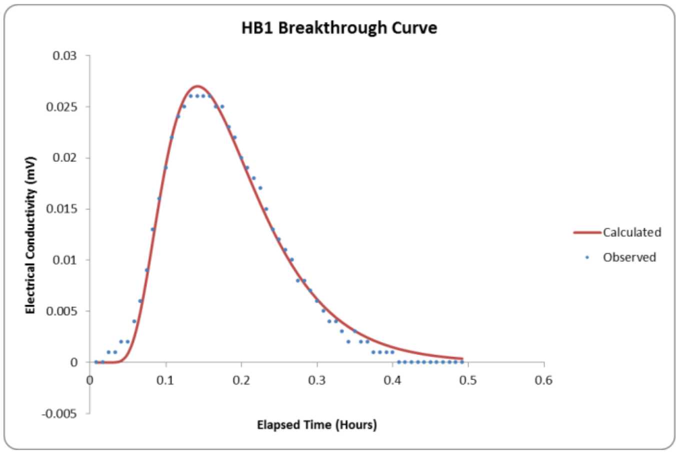
VelProbe output for 0612013_2cm_1231_finesand_15_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			149.2584	6.219098		
DISPERSIVITY (cm)			0.147456			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			4.540925			
RESDIUAL SUM OF SQUARES =				0.000127		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		146.2732	149.2584	152.2435		
DISPERSIVITY(cm)		0.13566	0.147456	0.159253		
Co(mV)		4.404697	4.540925	4.677153		
CRITICAL RSS VALUE =			0.00016			

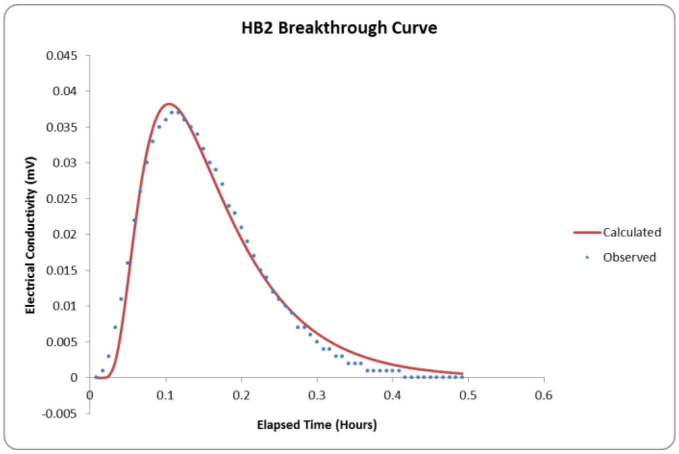
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.151537238	0.147456479	83.832772	53.918344	7.6611787	189.5525	149.2584	136.3381	136.3381	0	.	1.463158	0.941053	0.133688	7.659733	136.3381	136.3381
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0612013_2cm_1258_finesand_15_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			194.1192	8.088298		
DISPERSIVITY (cm)			0.12743			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			3.661865			
RESDIUAL SUM OF SQUARES =				3.57E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		192.178	194.1192	196.0604		
DISPERSIVITY(cm)		0.121059	0.12743	0.135076		
Co(mV)		3.588628	3.661865	3.735103		
CRITICAL RSS VALUE =			4.29E-05			

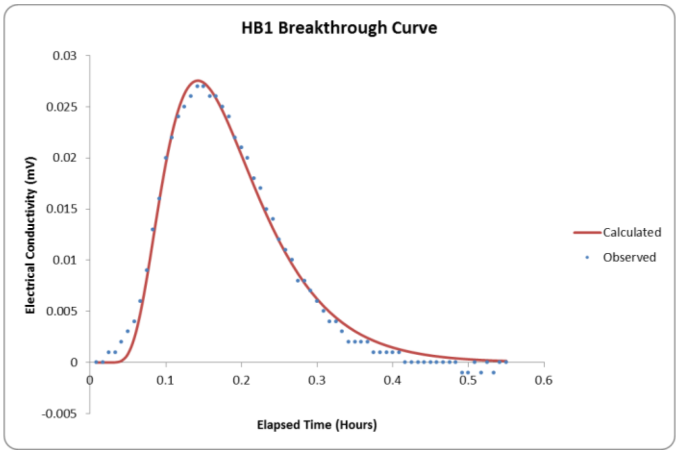
VelProbe output for 0612013_2cm_1258_finesand_15_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			150.5127	6.271363		
DISPERSIVITY (cm)			0.13151			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			3.96409			
RESDIUAL SUM OF SQUARES =				0.000133		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		147.5025	150.5127	153.523		
DISPERSIVITY(cm)		0.12099	0.13151	0.143346		
Co(mV)		3.845167	3.96409	4.083012		
CRITICAL RSS VALUE =			0.000159			

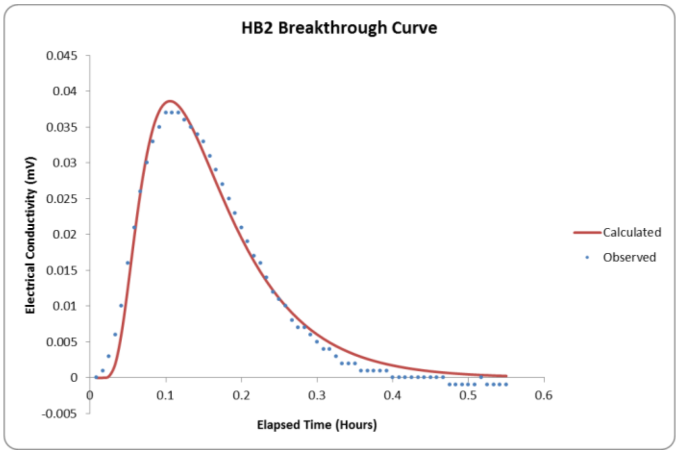
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.12743005	0.131510477	83.832772	53.918344	6.2219601	194.1192	150.5127	142.7205	142.7205	0	.	1.463158	0.941053	0.108573	6.220786	142.7205	142.7205
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0612013_2cm_1328_finesand_15_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			194.019	8.084123		
DISPERSIVITY (cm)			0.126071			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			3.712184			
RESDIUAL SUM OF SQUARES =				4.76E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		192.0788	194.019	195.9591		
DISPERSIVITY(cm)		0.118507	0.126071	0.133635		
Co(mV)		3.63794	3.712184	3.786427		
CRITICAL RSS VALUE =			5.61E-05			

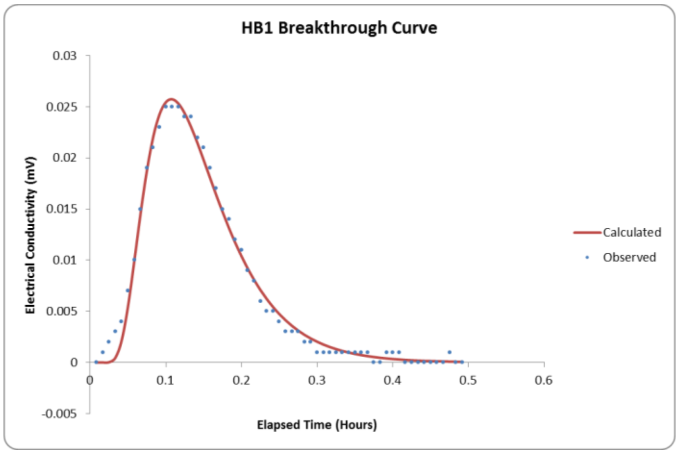
VelProbe output for 0612013_2cm_1328_finesand_15_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			150.6304	6.276265		
DISPERSIVITY (cm)			0.126491			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			3.95321			
RESDIUAL SUM OF SQUARES =				0.000151		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		147.6178	150.6304	153.643		
DISPERSIVITY(cm)		0.117637	0.126491	0.137875		
Co(mV)		3.834614	3.95321	4.071807		
CRITICAL RSS VALUE =			0.000178			

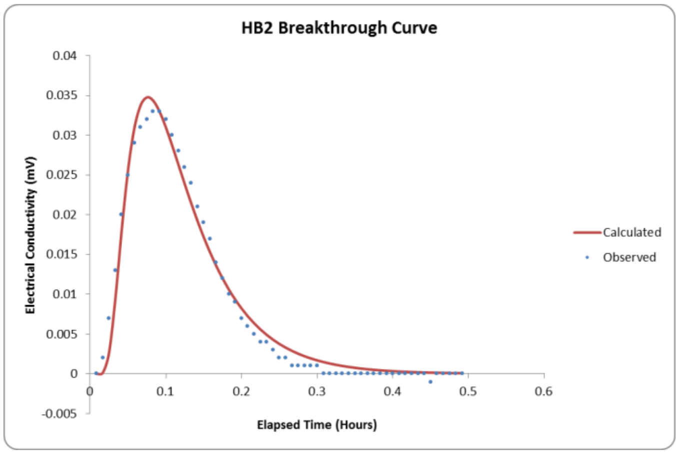
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.126071039	0.126491163	83.832772	53.918344	6.3396894	194.019	150.6304	142.385	142.385	-4.99E-15	.	1.463158	0.941053	0.110628	6.338493	142.385	142.385
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0612013_2cm_1424_finesand_30_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			250.7618	10.44841		
DISPERSIVITY (cm)			0.14331			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			3.647315			
RESDIUAL SUM OF SQUARES =				3.67E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		248.2541	250.7618	255.777		
DISPERSIVITY(cm)		0.133279	0.14331	0.153342		
Co(mV)		3.537896	3.647315	3.756735		
CRITICAL RSS VALUE =			4.41E-05			

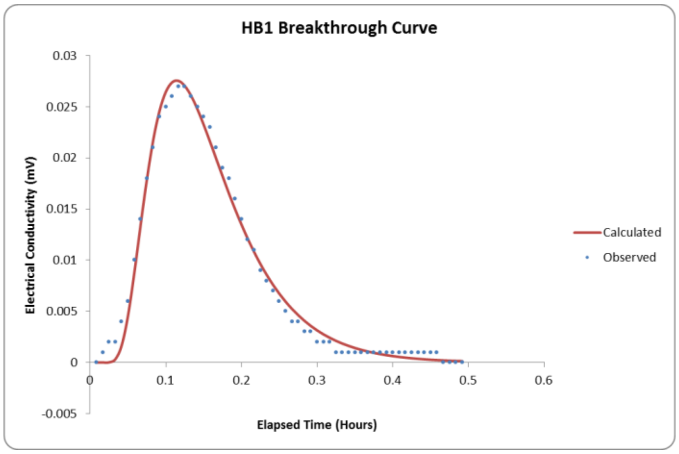
VelProbe output for 0612013_2cm_1424_finesand_30_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			202.9454	8.45606		
DISPERSIVITY (cm)			0.13724			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			3.655361			
RESDIUAL SUM OF SQUARES =				0.000119		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		196.8571	202.9454	209.0338		
DISPERSIVITY(cm)		0.124888	0.13724	0.152336		
Co(mV)		3.509147	3.655361	3.801576		
CRITICAL RSS VALUE =			0.000143			

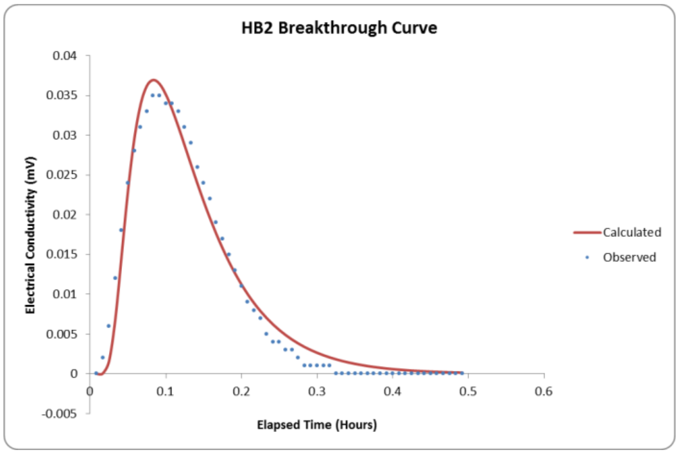
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.143310271	0.137239962	83.832772	53.918344	10.438952	250.7618	202.9454	173.4103	173.4103	4.097E-15	.	1.463158	0.941053	0.18216	10.43698	173.4103	173.4103
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0612013_2cm_1456_finesand_30_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			234.5283	9.772012		
DISPERSIVITY (cm)			0.146362			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			3.940627			
RESDIUAL SUM OF SQUARES =				4.38E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		232.183	234.5283	236.8736		
DISPERSIVITY(cm)		0.13758	0.146362	0.156607		
Co(mV)		3.822408	3.940627	4.058846		
CRITICAL RSS VALUE =			5.26E-05			

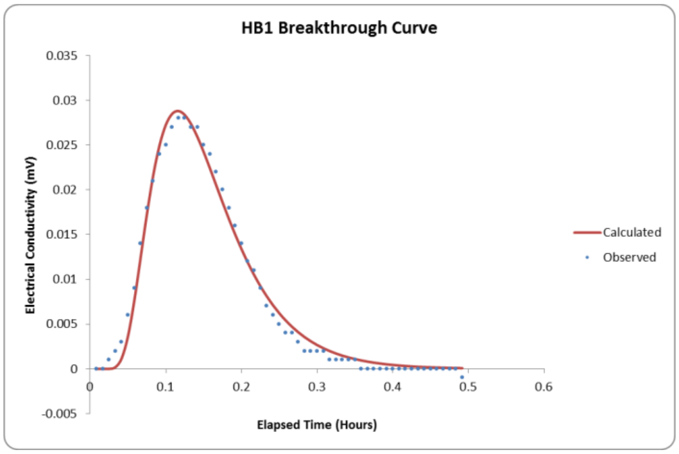
VelProbe output for 0612013_2cm_1456_finesand_30_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			185.8835	7.745145		
DISPERSIVITY (cm)			0.134936			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			3.862618			
RESDIUAL SUM OF SQUARES =				0.000176		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		180.307	185.8835	191.46		
DISPERSIVITY(cm)		0.121443	0.134936	0.151128		
Co(mV)		3.669487	3.862618	4.017123		
CRITICAL RSS VALUE =			0.000211			

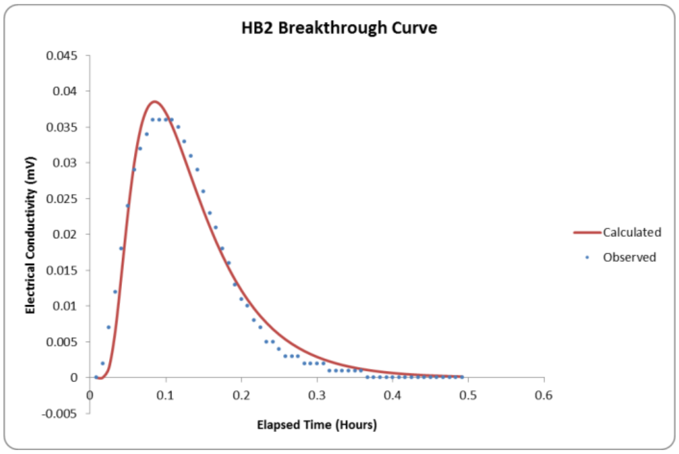
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.14636205	0.134936156	83.832772	53.918344	8.2963315	234.5283	185.8835	167.12	167.12	-4.252E-15	.	1.463158	0.941053	0.144771	8.294766	167.12	167.12
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0612013_2cm_1526_finesand_30_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			237.2294	9.88456		
DISPERSIVITY (cm)			0.130714			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			3.942514			
RESDIUAL SUM OF SQUARES =				5.73E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		232.4848	237.2294	241.974		
DISPERSIVITY(cm)		0.121564	0.130714	0.141172		
Co(mV)		3.824238	3.942514	4.060789		
CRITICAL RSS VALUE =			6.88E-05			

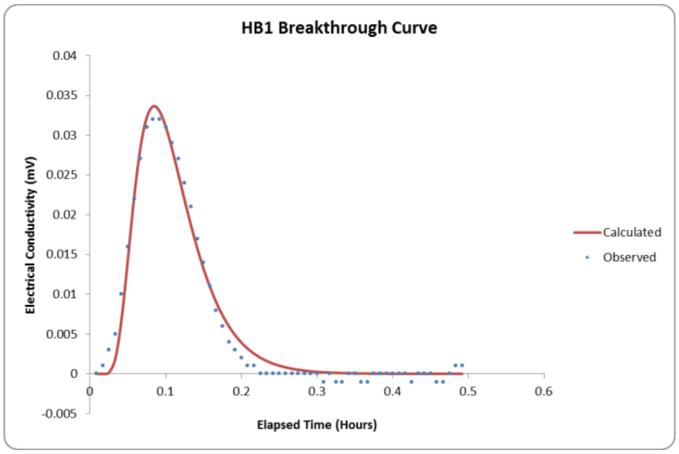
VelProbe output for 0612013_2cm_1526_finesand_30_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			183.2158	7.633991		
DISPERSIVITY (cm)			0.133956			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			4.020542			
RESDIUAL SUM OF SQUARES =				0.000203		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			300			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		177.7193	183.2158	188.7123		
DISPERSIVITY(cm)		0.119221	0.133956	0.150031		
Co(mV)		3.819515	4.020542	4.181364		
CRITICAL RSS VALUE =			0.000243			

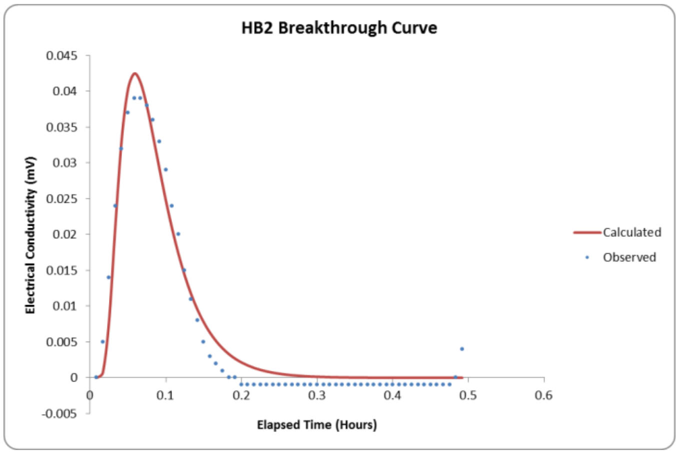
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.130714405	0.133955859	83.832772	53.918344	5.8682131	237.2294	183.2158	175.3895	175.3895	-4.051E-15	.	1.463158	0.941053	0.1024	5.867106	175.3895	175.3895
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0612013_2cm_1635_finesand_45_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			330.956	13.78983		
DISPERSIVITY (cm)			0.11813			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			4.418265			
RESDIUAL SUM OF SQUARES =				9.74E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		324.3369	330.956	337.5751		
DISPERSIVITY(cm)		0.106317	0.11813	0.131124		
Co(mV)		4.241535	4.418265	4.594996		
CRITICAL RSS VALUE =			0.000117			

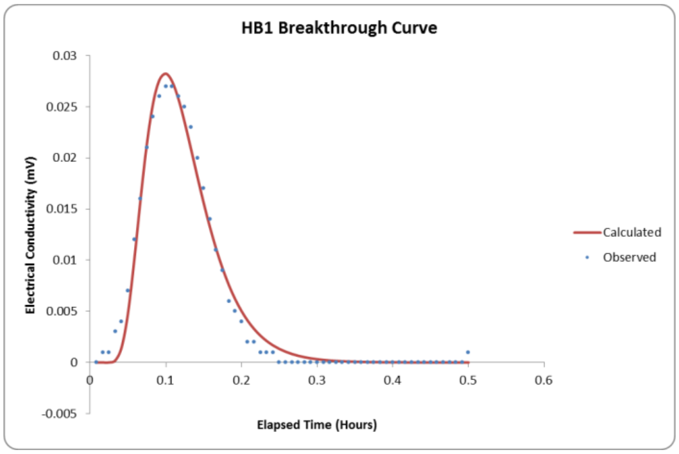
VelProbe output for 0612013_2cm_1635_finesand_45_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			280.7632	11.69847		
DISPERSIVITY (cm)			0.111512			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			4.157191			
RESDIUAL SUM OF SQUARES =				0.000291		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		269.5327	280.7632	291.9937		
DISPERSIVITY(cm)		0.095901	0.111512	0.131584		
Co(mV)		3.866188	4.157191	4.406622		
CRITICAL RSS VALUE =			0.00035			

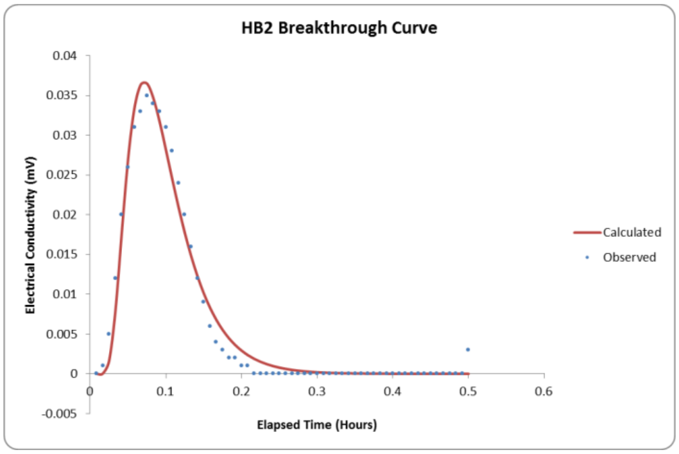
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.118130106	0.111512229	83.832772	53.918344	15.953562	330.956	280.7632	213.9966	213.9966	-6.641E-15	.	1.463158	0.941053	0.27839	15.95055	213.9966	213.9966
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0612013_2cm_1703_finesand_45_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			291.2561	12.13567		
DISPERSIVITY (cm)			0.097551			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			3.425795			
RESDIUAL SUM OF SQUARES =				6.48E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		285.431	291.2561	297.0812		
DISPERSIVITY(cm)		0.088771	0.097551	0.108281		
Co(mV)		3.288763	3.425795	3.562827		
CRITICAL RSS VALUE =			7.76E-05			

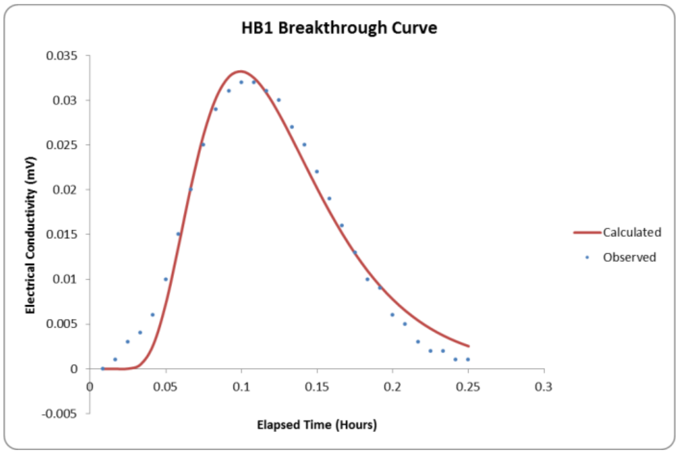
VelProbe output for 0612013_2cm_1703_finesand_45_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			242.0929	10.0872		
DISPERSIVITY (cm)			0.092662			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			3.353031			
RESDIUAL SUM OF SQUARES =				0.000146		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		234.8301	242.0929	249.3556		
DISPERSIVITY(cm)		0.082469	0.092662	0.104708		
Co(mV)		3.185379	3.353031	3.520682		
CRITICAL RSS VALUE =			0.000175			

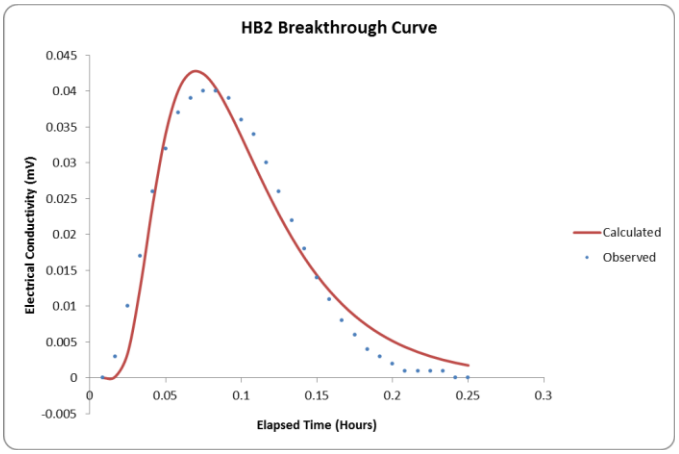
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.097550559	0.092661644	83.832772	53.918344	13.440444	291.2561	242.0929	193.8508	193.8508	0	.	1.463158	0.941053	0.234536	13.43791	193.8508	193.8508
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0612013_2cm_1732_finesand_45_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			283.3839	11.80766		
DISPERSIVITY (cm)			0.114413			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			4.309212			
RESDIUAL SUM OF SQUARES =				9.28E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		274.8824	283.3839	291.8855		
DISPERSIVITY(cm)		0.099539	0.114413	0.132719		
Co(mV)		4.050659	4.309212	4.567764		
CRITICAL RSS VALUE =			0.000132			

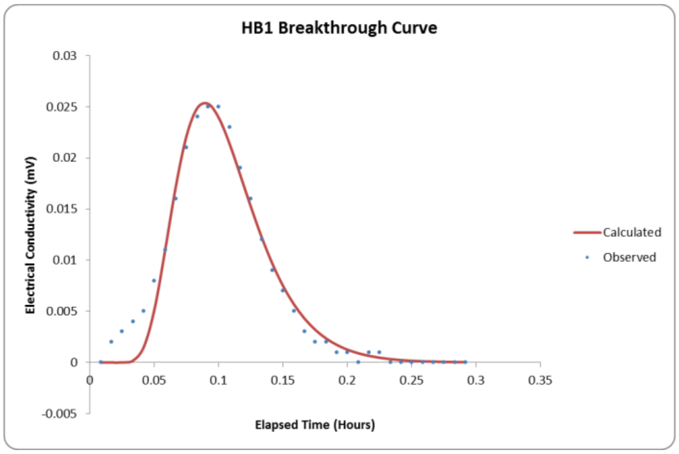
VelProbe output for 0612013_2cm_1732_finesand_45_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			234.6881	9.77867		
DISPERSIVITY (cm)			0.113253			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			4.200716			
RESDIUAL SUM OF SQUARES =				0.000237		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		222.9537	234.6881	246.4225		
DISPERSIVITY(cm)		0.092867	0.113253	0.137036		
Co(mV)		3.864659	4.200716	4.536774		
CRITICAL RSS VALUE =			0.000338			

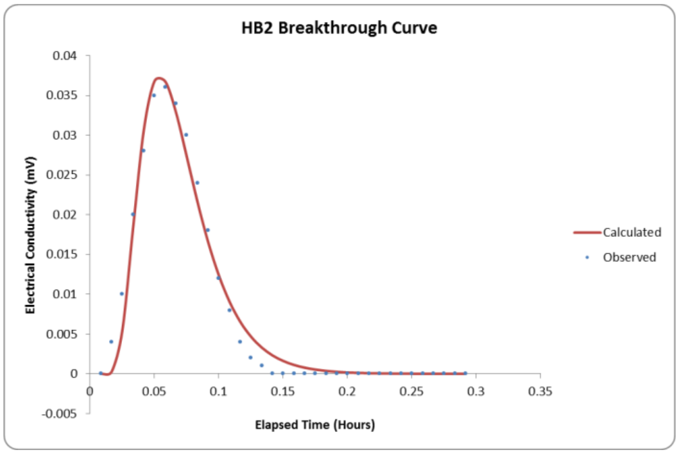
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.114413106	0.11325254	83.832772	53.918344	13.009776	283.3839	234.6881	189.6014	189.6014	0	.	1.463158	0.941053	0.227021	13.00732	189.6014	189.6014
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0612013_2cm_1806_finesand_75_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			335.1183	13.96326		
DISPERSIVITY (cm)			0.075752			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			2.760057			
RESDIUAL SUM OF SQUARES =				6.27E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		325.0647	335.1183	345.1718		
DISPERSIVITY(cm)		0.064389	0.075752	0.090903		
Co(mV)		2.566853	2.760057	2.953261		
CRITICAL RSS VALUE =			8.51E-05			

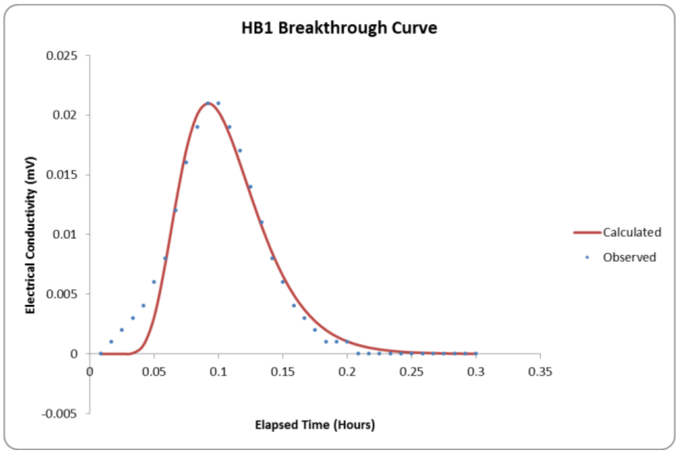
VelProbe output for 0612013_2cm_1806_finesand_75_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			334.5611	13.94005		
DISPERSIVITY (cm)			0.075021			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			3.144287			
RESDIUAL SUM OF SQUARES =				9.46E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		324.5243	334.5611	347.9436		
DISPERSIVITY(cm)		0.063768	0.075021	0.088525		
Co(mV)		2.924187	3.144287	3.332945		
CRITICAL RSS VALUE =			0.000128			

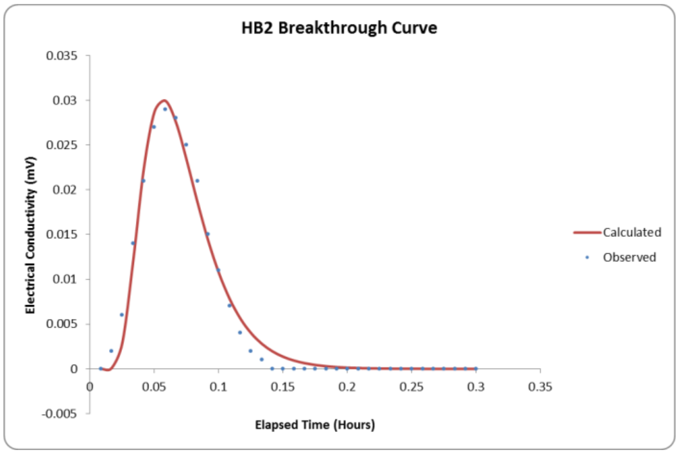
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.075752245	0.075021112	83.832772	53.918344	43.6712	335.1183	334.5611	184.0421	184.0421	3.861E-15	.	1.463158	0.941053	0.762062	43.66296	184.0421	184.0421
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0612013_2cm_1827_finesand_75_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			327.9075	13.66281		
DISPERSIVITY (cm)			0.070626			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			2.210943			
RESDIUAL SUM OF SQUARES =				4.26E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		318.0703	327.9075	337.7447		
DISPERSIVITY(cm)		0.059325	0.070626	0.084044		
Co(mV)		2.056177	2.210943	2.365709		
CRITICAL RSS VALUE =			5.73E-05			

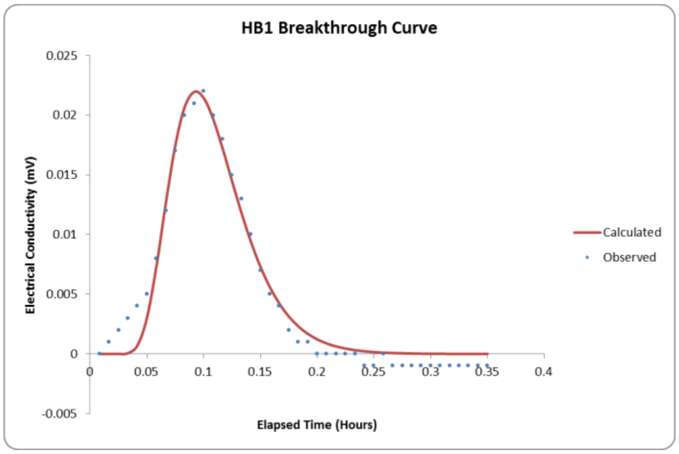
VelProbe output for 0612013_2cm_1827_finesand_75_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			324.367	13.51529		
DISPERSIVITY (cm)			0.069059			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			2.445443			
RESDIUAL SUM OF SQUARES =				5.01E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		314.636	324.367	334.098		
DISPERSIVITY(cm)		0.060082	0.069059	0.080109		
Co(mV)		2.298717	2.445443	2.59217		
CRITICAL RSS VALUE =			6.75E-05			

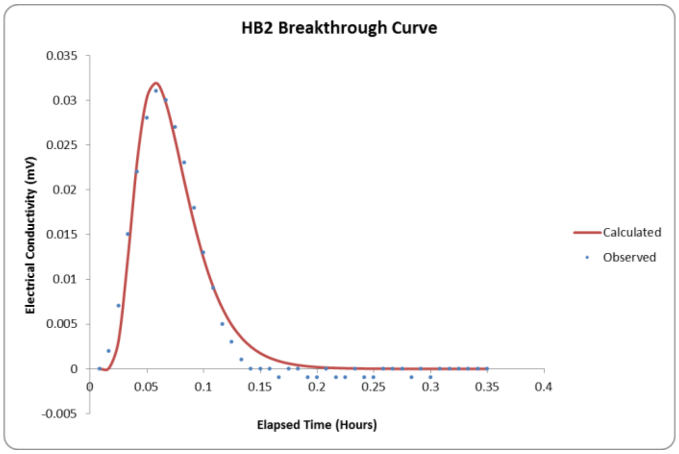
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.070625504	0.069059402	83.832772	53.918344	41.765995	327.9075	324.367	180.6461	180.6461	-3.933E-15	.	1.463158	0.941053	0.728817	41.75812	180.6461	180.6461
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0612013_2cm_1846_finesand_75_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			322.7662	13.44859		
DISPERSIVITY (cm)			0.070351			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			2.318846			
RESDIUAL SUM OF SQUARES =				5.52E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		313.0832	322.7662	332.4492		
DISPERSIVITY(cm)		0.059799	0.070351	0.083718		
Co(mV)		2.156526	2.318846	2.457976		
CRITICAL RSS VALUE =			7.13E-05			

VelProbe output for 0612013_2cm_1846_finesand_75_0.5gL_0.1 – Half Bridge 2



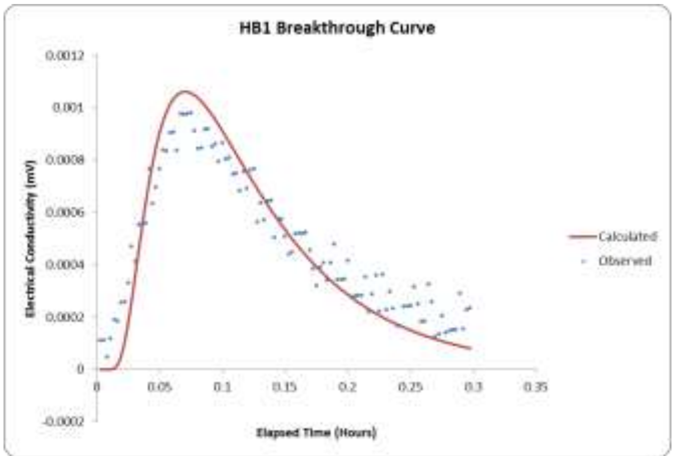
OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			318.6256	13.27607		
DISPERSIVITY (cm)			0.071753			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			2.638364			
RESDIUAL SUM OF SQUARES =				8.06E-05		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			200			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		309.0668	318.6256	328.1844		
DISPERSIVITY(cm)		0.061708	0.071753	0.083951		
Co(mV)		2.480062	2.638364	2.796666		
CRITICAL RSS VALUE =			0.000104			

Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.070351277	0.071752958	83.832772	53.918344	41.3441	322.7662	318.6256	177.9638	177.9638	0	.	1.463158	0.941053	0.721455	41.3363	177.9638	177.9638
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VELPROBE OUTPUT

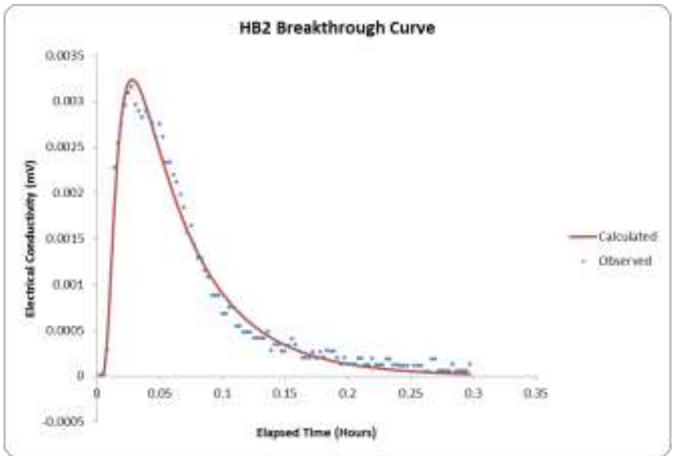
6 cm PVP Data for Gravel

VelProbe output for 0626013_6cm_1257_gravel_45_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			917.0117	38.20882		
DISPERSIVITY (cm)			0.799118			
PULSE WIDTH (cm)			0.038386			
RF			1			
Co (mV)			0.142567			
RESDIUAL SUM OF SQUARES =				9.47E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			750			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		852.8208	917.0117	953.6921		
DISPERSIVITY(cm)		0.759162	0.799118	1.238632		
PULSE WIDTH (cm)		0.032244	0.038386	0.039154		
Co(mV)		0.119757	0.142567	0.145419		
CRITICAL RSS VALUE =			1.24E-06			

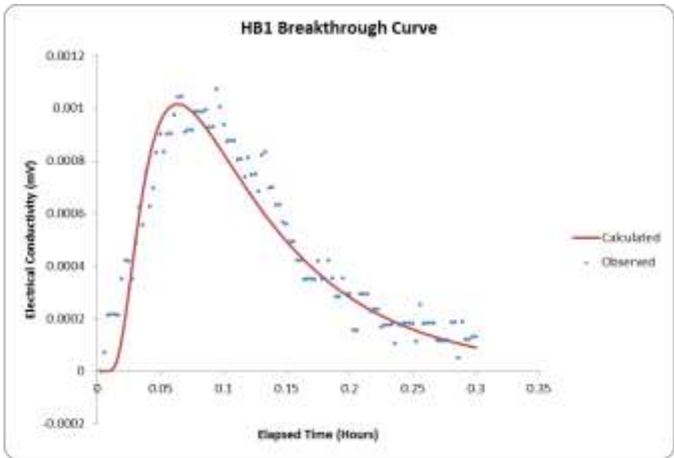
VelProbe output for 06262013_6cm_1257_gravel_45_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			1144.663	47.6943		
DISPERSIVITY (cm)			0.737438			
PULSE WIDTH (cm)			0.023878			
RF			1			
Co (mV)			0.47			
RESDIUAL SUM OF SQUARES =				1.44E-06		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			750			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		1110.323	1144.663	1179.003		
DISPERSIVITY(cm)		0.693191	0.737438	0.796433		
PULSE WIDTH (cm)		0.023162	0.023878	0.024595		
Co(mV)		0.4559	0.47	0.4841		
CRITICAL RSS VALUE =			1.64E-06			

Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.799117569	0.737437596	77.92226	48.128455	91.933443	917.0117	1144.663	655.7813	655.7813	1.959E-12	.	1.36	0.84	-1.53735	-88.0839	-655.781	-655.781
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535		0.801119					
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0626013_6cm_1317_gravel_45_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES

		cm/hr
VELOCITY(cm/d)	924.4628	38.51928
DISPERSIVITY (cm)	0.965636	
PULSE WIDTH (cm)	0.000771	
RF	1	
Co (mV)	7.138968	

RESDIUAL SUM OF SQUARES = 8.74E-07

INITIAL GUESSES AND INPUT OF PARAMETERS

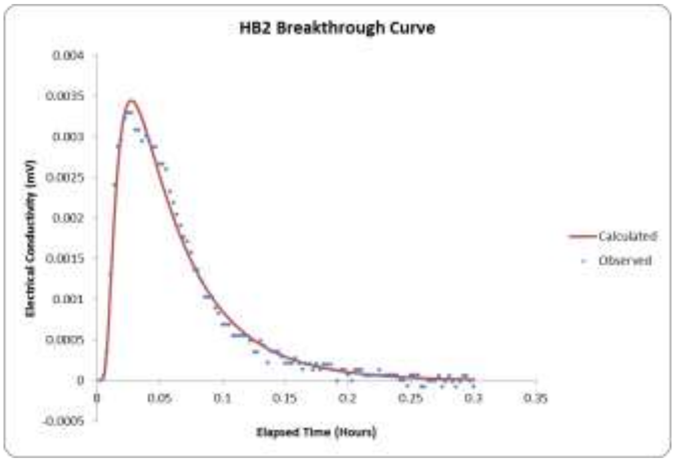
		FIX
VELOCITY(cm/d)	900	
DISPERSIVITY (cm)	0.1	
PULSE WIDTH (cm)	0.01	
RF	1	Y
Co (mV)	2	
DISTANCE FROM SOURCE (cm)	4.08	Y
DIFFUSION COEFF (cm^2/sec)	0.000001	Y

95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS

Parameter	Low	Optimized	High
VELOCITY(cm/d)	822.7719	924.4628	942.952
DISPERSIVITY(cm)	0.733884	0.965636	1.033231
PULSE WIDTH (cm)	0.00074	0.000771	0.000832
Co(mV)	6.853409	7.138968	7.710085

CRITICAL RSS VALUE = 9.98E-07

VelProbe output for 06262013_6cm_1317_gravel_45_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES

		cm/hr
VELOCITY(cm/d)	1209.192	50.38302
DISPERSIVITY (cm)	0.70532	
PULSE WIDTH (cm)	0.017766	
RF	1	
Co (mV)	0.668291	

RESDIUAL SUM OF SQUARES = 1.32E-06

INITIAL GUESSES AND INPUT OF PARAMETERS

		FIX
VELOCITY(cm/d)	1200	
DISPERSIVITY (cm)	0.1	
PULSE WIDTH (cm)	0.01	
RF	1	Y
Co (mV)	2	
DISTANCE FROM SOURCE (cm)	2.52	Y
DIFFUSION COEFF (cm^2/sec)	0.000001	Y

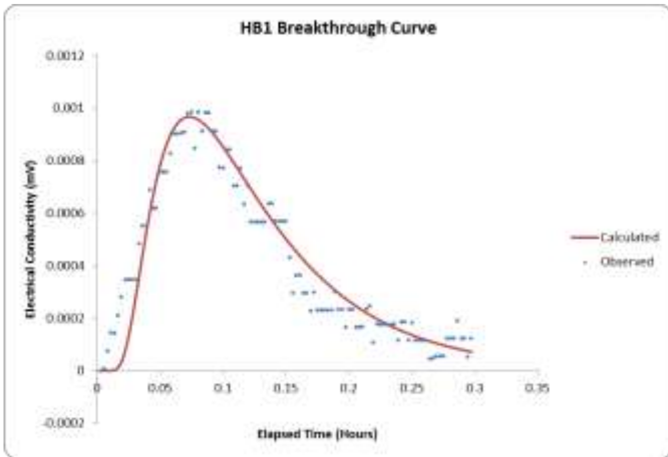
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS

Parameter	Low	Optimized	High
VELOCITY(cm/d)	1185.009	1209.192	1245.468
DISPERSIVITY(cm)	0.663	0.70532	0.754692
PULSE WIDTH (cm)	0.017233	0.017766	0.018299
Co(mV)	0.648242	0.668291	0.68834

CRITICAL RSS VALUE = 1.5E-06

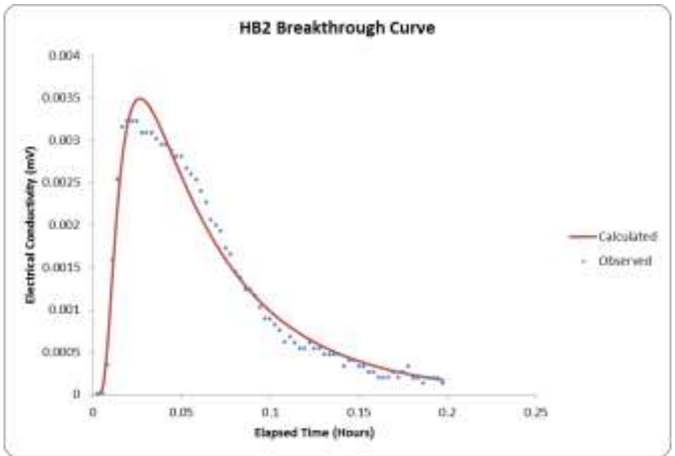
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.705319615	0.965636432	48.128455	77.92226	98.440977	1209.192	924.4628	738.2711	738.2711	-2.333E-12	.	0.84	1.36	-1.4238	-81.5776	-738.271	-738.271
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535		1.307995					
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0626013_6cm_1348_gravel_45_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			904.6733	37.69472		
DISPERSIVITY (cm)			0.746936			
PULSE WIDTH (cm)			0.001625			
RF			1			
Co (mV)			3.020422			
RESDIUAL SUM OF SQUARES =				7.44E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			900			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		895.6266	904.6733	1022.281		
DISPERSIVITY(cm)		0.70959	0.746936	1.083058		
PULSE WIDTH (cm)		0.00143	0.001625	0.001657		
Co(mV)		2.657972	3.020422	3.080831		
CRITICAL RSS VALUE =			8.51E-07			

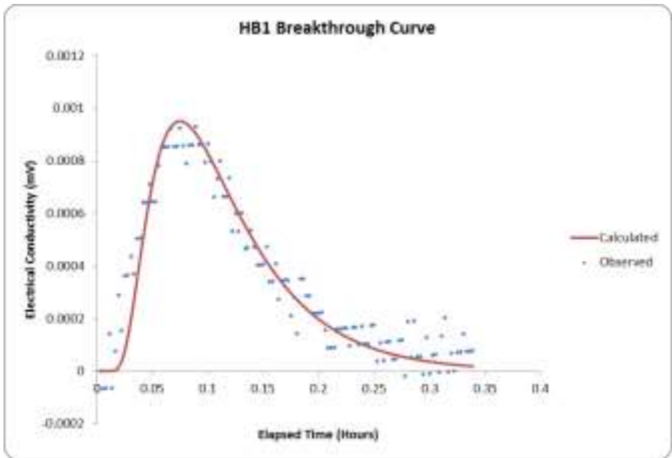
VelProbe output for 06262013_6cm_1348_gravel_45_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			1135.543	47.31429		
DISPERSIVITY (cm)			0.811835			
PULSE WIDTH (cm)			0.033153			
RF			1			
Co (mV)			0.368991			
RESDIUAL SUM OF SQUARES =				1.85E-06		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			900			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		1090.121	1135.543	1180.965		
DISPERSIVITY(cm)		0.73877	0.811835	0.893018		
PULSE WIDTH (cm)		0.031826	0.033153	0.034479		
Co(mV)		0.354231	0.368991	0.383751		
CRITICAL RSS VALUE =			2.26E-06			

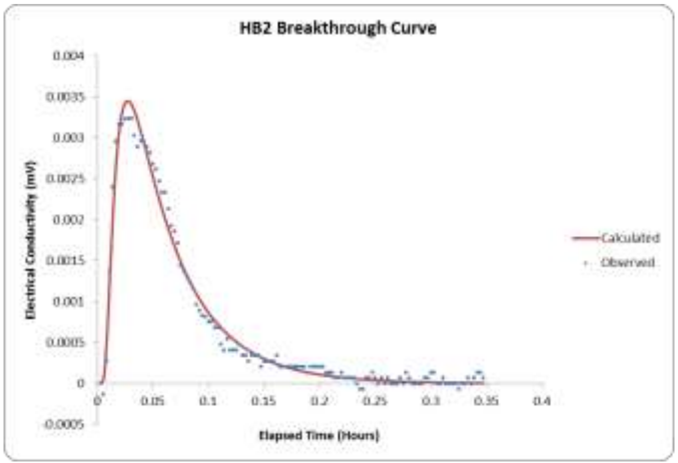
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.746936431	0.811834861	77.92226	48.128455	92.765535	904.6733	1135.543	655.2616	655.2616	2E-12	.	1.36	0.84	-1.52283	-87.252	-655.262	-655.262
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0626013_6cm_1411_gravel_45_0.5gL_0.5 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			961.2422	40.05176		
DISPERSIVITY (cm)			0.602992			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			0.451087			
RESDIUAL SUM OF SQUARES =				7.9E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			800			
DISPERSIVITY (cm)			0.2			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		942.0174	961.2422	1028.529		
DISPERSIVITY(cm)		0.584903	0.602992	0.970818		
Co(mV)		0.410489	0.451087	0.464619		
CRITICAL RSS VALUE =			8.63E-07			

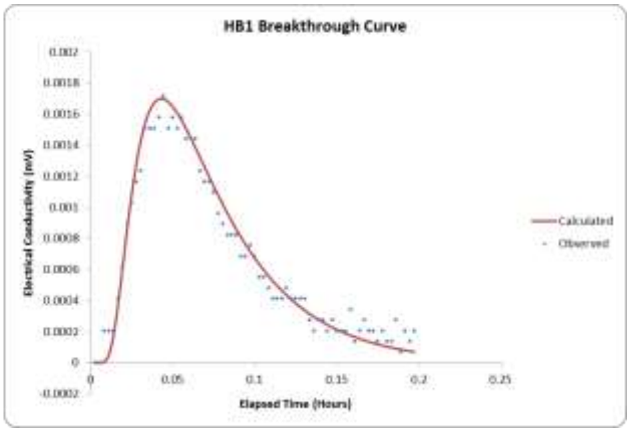
VelProbe output for 06262013_6cm_1411_gravel_45_0.5gL_0.5 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			1207.046	50.29358		
DISPERSIVITY (cm)			0.719397			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			1.192296			
RESDIUAL SUM OF SQUARES =				1.62E-06		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			800			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		1182.905	1207.046	1231.187		
DISPERSIVITY(cm)		0.683427	0.719397	0.755367		
Co(mV)		1.16845	1.192296	1.216142		
CRITICAL RSS VALUE =			1.77E-06			

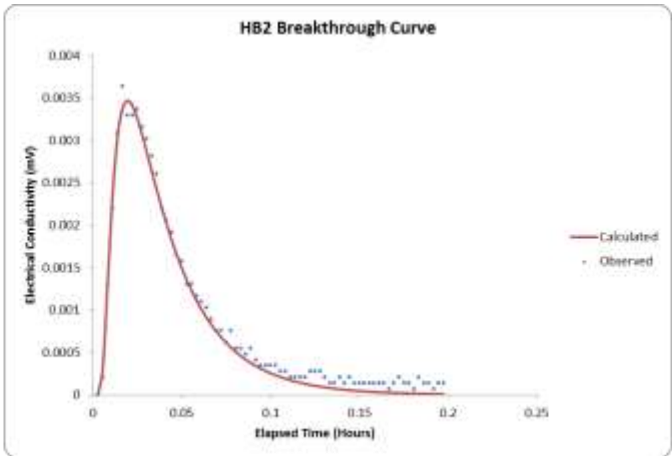
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.719396842	0.602992349	48.128455	77.92226	92.826783	1207.046	961.2422	696.8991	696.8991	-1.994E-12	.	0.84	1.36	-1.52177	-87.1907	-696.899	-696.899
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0626013_6cm_1456_gravel_45_0.5gL_1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			1550.404	64.60018		
DISPERSIVITY (cm)			0.73379			
PULSE WIDTH (cm)			0.004156			
RF			1			
Co (mV)			2.063504			
RESDIUAL SUM OF SQUARES =				5.33E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			1500			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.02			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		1519.396	1550.404	1627.925		
DISPERSIVITY(cm)		0.6971	0.73379	0.902561		
PULSE WIDTH (cm)		0.003699	0.004156	0.004198		
Co(mV)		1.836519	2.063504	2.084139		
CRITICAL RSS VALUE =			6.52E-07			

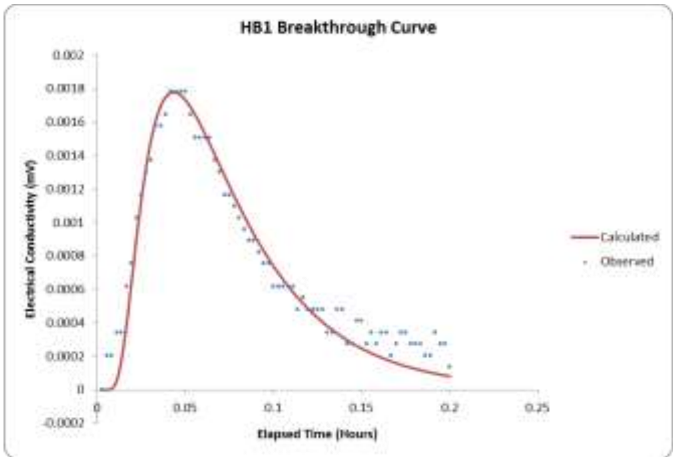
VelProbe output for 06262013_6cm_1456_gravel_45_0.5gL_1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			1827.144	76.13101		
DISPERSIVITY (cm)			0.619265			
PULSE WIDTH (cm)			0.019697			
RF			1			
Co (mV)			0.592273			
RESDIUAL SUM OF SQUARES =				8.88E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			1400			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.02			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		1680.973	1827.144	1845.416		
DISPERSIVITY(cm)		0.551146	0.619265	0.656421		
PULSE WIDTH (cm)		0.019303	0.019697	0.021075		
Co(mV)		0.580428	0.592273	0.633732		
CRITICAL RSS VALUE =			1.09E-06			

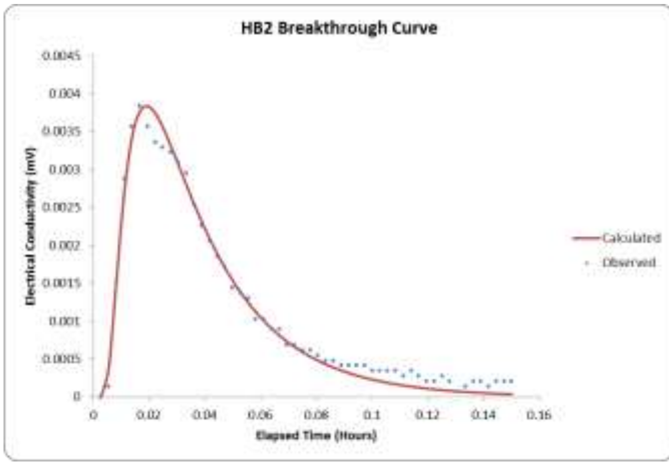
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.73378952	0.619265041	77.92226	48.128455	82.315753	1550.404	1827.144	980.7246	980.7246	-5.796E-15	.	1.36	0.84	1.43641	82.30022	980.7246	980.7246
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0626013_6cm_1519_gravel_45_0.5gL_1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			1518.1	63.25417		
DISPERSIVITY (cm)			0.757297			
PULSE WIDTH (cm)			0.004297			
RF			1			
Co (mV)			2.108169			
RESDIUAL SUM OF SQUARES =				9.17E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			1200			
DISPERSIVITY (cm)			0.3			
PULSE WIDTH (cm)			0.03			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		1457.376	1518.1	1594.005		
DISPERSIVITY(cm)		0.719432	0.757297	1.037497		
PULSE WIDTH (cm)		0.003997	0.004297	0.004469		
Co(mV)		1.960598	2.108169	2.192496		

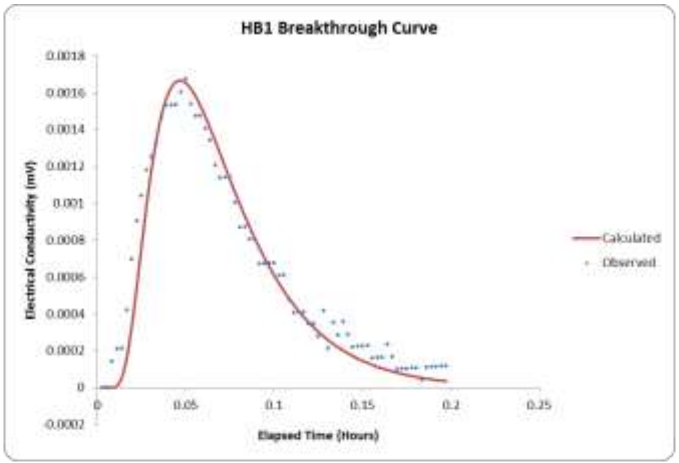
VelProbe output for 06262013_6cm_1519_gravel_45_0.5gL_1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			1910.543	79.60596		
DISPERSIVITY (cm)			0.597282			
PULSE WIDTH (cm)			0.004808			
RF			1			
Co (mV)			2.670407			
RESDIUAL SUM OF SQUARES =				9.23E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			1100			
DISPERSIVITY (cm)			0.3			
PULSE WIDTH (cm)			0.03			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		1834.121	1910.543	1967.859		
DISPERSIVITY(cm)		0.567417	0.597282	0.698819		
PULSE WIDTH (cm)		0.004568	0.004808	0.004952		
Co(mV)		2.536887	2.670407	2.750519		
CRITICAL RSS VALUE =			1.2E-06			

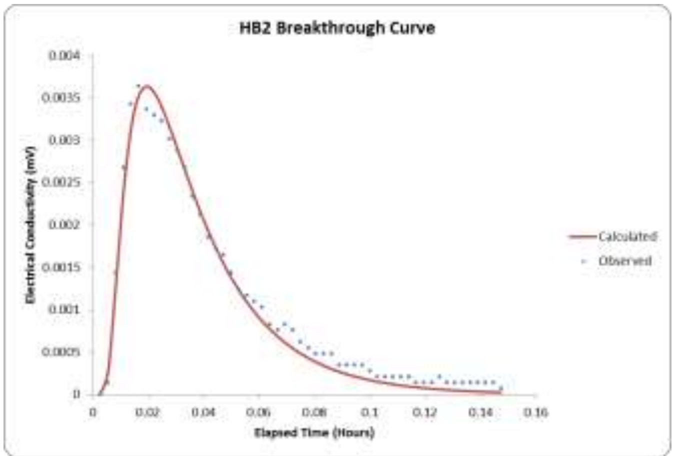
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.757296927	0.597281578	77.92226	48.128455	93.155129	1518.1	1910.543	1106.3	1106.3	2.009E-12	.	1.36	0.84	-1.51604	-86.8624	-1106.3	-1106.3
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0626013_6cm_1534_gravel_45_0.5gL_1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			1572.771	65.53211		
DISPERSIVITY (cm)			0.557337			
PULSE WIDTH (cm)			0.006097			
RF			1			
Co (mV)			1.262648			
RESDIUAL SUM OF SQUARES =				8.24E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			1200			
DISPERSIVITY (cm)			0.35			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		1541.315	1572.771	1714.32		
DISPERSIVITY(cm)		0.540617	0.557337	0.930752		
PULSE WIDTH (cm)		0.00567	0.006097	0.00634		
Co(mV)		1.174263	1.262648	1.313154		

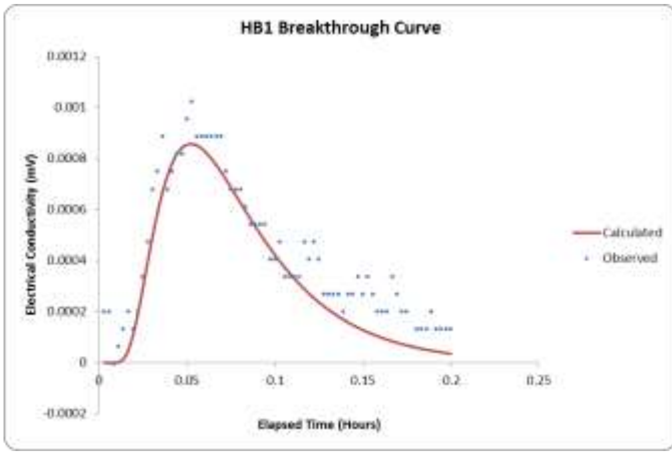
VelProbe output for 06262013_6cm_1534_gravel_45_0.5gL_1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			1966.166	81.92359		
DISPERSIVITY (cm)			0.538249			
PULSE WIDTH (cm)			0.00598			
RF			1			
Co (mV)			1.984369			
RESDIUAL SUM OF SQUARES =				8.77E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			1200			
DISPERSIVITY (cm)			0.35			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		1887.52	1966.166	2025.151		
DISPERSIVITY(cm)		0.516719	0.538249	0.672812		
PULSE WIDTH (cm)		0.005741	0.00598	0.006219		
Co(mV)		1.904994	1.984369	2.063744		
CRITICAL RSS VALUE =			1.15E-06			

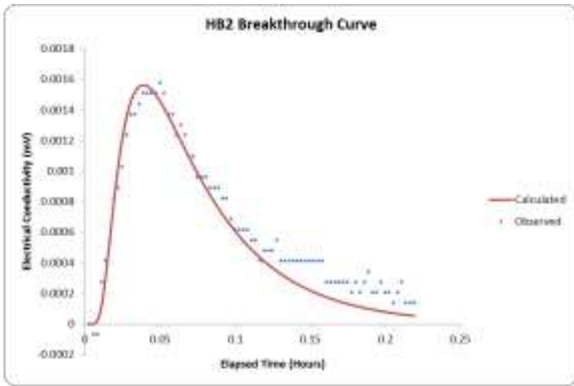
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.557336646	0.538249405	77.92226	48.128455	92.160287	1572.771	1966.166	1128.609	1128.609	1.974E-12	.	1.36	0.84	-1.5334	-87.8571	-1128.61	-1128.61
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0705013_6cm_1445_gravel_45_0.5gL_0.25 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			1393.058	58.04407		
DISPERSIVITY (cm)			0.577907			
PULSE WIDTH (cm)			0.00574			
RF			1			
Co (mV)			0.699092			
RESDIUAL SUM OF SQUARES =				8.88E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			900			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		1198.03	1393.058	1448.78		
DISPERSIVITY(cm)		0.473884	0.577907	0.785954		
PULSE WIDTH (cm)		0.005453	0.00574	0.007233		
Co(mV)		0.664138	0.699092	0.880857		
CRITICAL RSS VALUE =			1.08E-06			

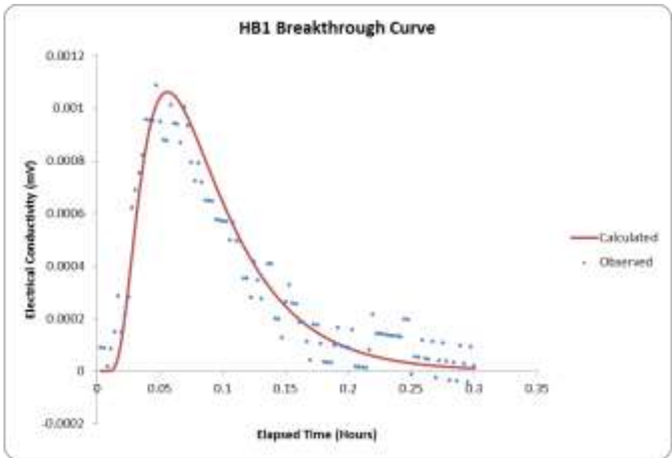
VelProbe output for 0705013_6cm_1445_gravel_45_0.5gL_0.25 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			970.7249	40.44687		
DISPERSIVITY (cm)			0.55456			
PULSE WIDTH (cm)			0.000584			
RF			1			
Co (mV)			8.815381			
RESDIUAL SUM OF SQUARES =				8.26E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			700			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		805.7017	970.7249	980.4322		
DISPERSIVITY(cm)		0.471376	0.55456	0.626653		
PULSE WIDTH (cm)		0.000555	0.000584	0.000637		
Co(mV)		8.374612	8.815381	9.608766		
CRITICAL RSS VALUE =			1.32E-06			

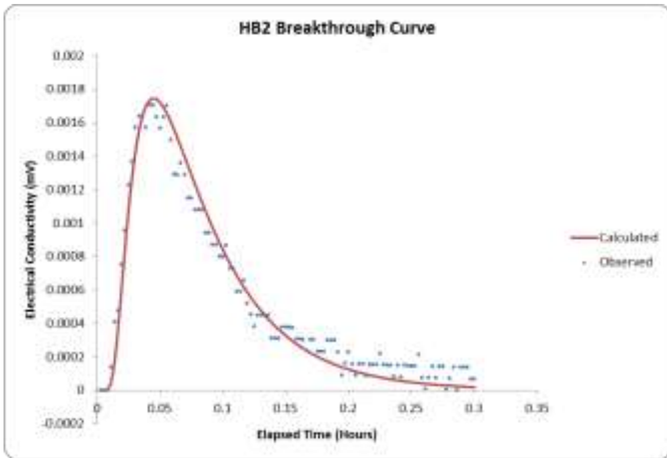
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.577907145	0.554560263	77.92226	48.128455	1.3807814	1393.058	970.7249	1163.604	1163.604	-4.885E-15	.	1.36	0.84	0.024095	1.380521	1163.604	1163.604
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0705013_6cm_1500_gravel_45_0.5gL_0.25 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES					
			cm/hr		
VELOCITY(cm/d)		1252.948	52.20619		
DISPERSIVITY (cm)		0.645391			
PULSE WIDTH (cm)		0.01			
RF		1			
Co (mV)		0.515133			
RESDIUAL SUM OF SQUARES =			8.25E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS					
					FIX
VELOCITY(cm/d)		800			
DISPERSIVITY (cm)		0.1			
PULSE WIDTH (cm)		0.01			Y
RF		1			Y
Co (mV)		2			
DISTANCE FROM SOURCE (cm)		4.08			Y
DIFFUSION COEFF (cm^2/sec)		0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS					
Parameter	Low	Optimized	High		
VELOCITY(cm/d)	1240.419	1252.948	1440.891		
DISPERSIVITY(cm)	0.62603	0.645391	1.07135		
Co(mV)	0.437863	0.515133	0.525436		
CRITICAL RSS VALUE =		9.12E-07			

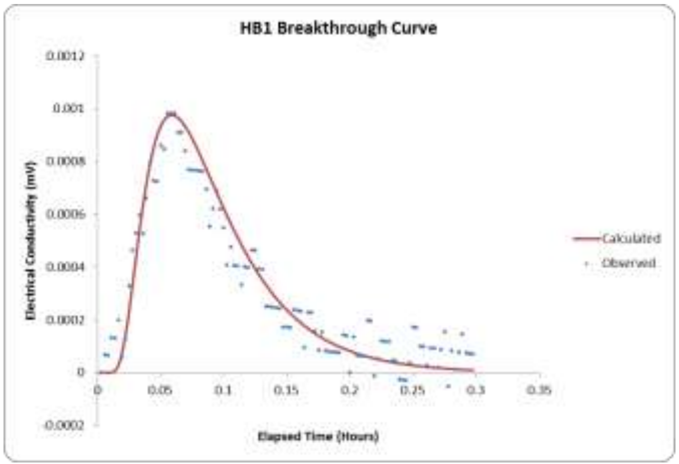
VelProbe output for 0705013_6cm_1500_gravel_45_0.5gL_0.25 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			881.2398	36.71833		
DISPERSIVITY (cm)			0.574267			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			0.603524			
RESDIUAL SUM OF SQUARES =				9.23E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			800			
DISPERSIVITY (cm)			0.2			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		872.4274	881.2398	942.9266		
DISPERSIVITY(cm)		0.562782	0.574267	0.735062		
Co(mV)		0.50696	0.603524	0.603524		
CRITICAL RSS VALUE =			1.02E-06			

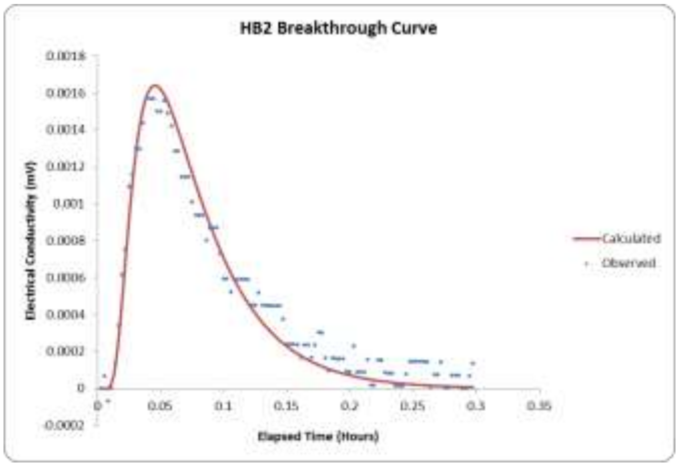
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.574267135	0.645391448	48.128455	77.92226	1.9662505	881.2398	1252.948	1034.186	1034.186	0	.	0.84	1.36	0.034311	1.96588	1034.186	1034.186
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0705013_6cm_1521_gravel_45_0.5gL_0.25 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			1220.352	50.84801		
DISPERSIVITY (cm)			0.603878			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			0.463377			
RESDIUAL SUM OF SQUARES =				6.78E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			800			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		1208.149	1220.352	1342.387		
DISPERSIVITY(cm)		0.579723	0.603878	0.923933		
Co(mV)		0.379969	0.463377	0.468011		
CRITICAL RSS VALUE =			7.5E-07			

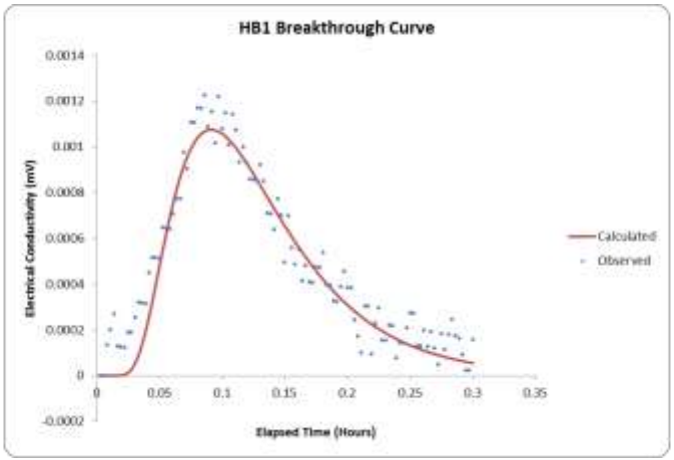
VelProbe output for 0705013_6cm_1521_gravel_45_0.5gL_0.25 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			921.9151	38.41313		
DISPERSIVITY (cm)			0.437065			
PULSE WIDTH (cm)			0.01			
RF			1			
Co (mV)			0.505432			
RESDIUAL SUM OF SQUARES =				8.97E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			800			
DISPERSIVITY (cm)			0.27			
PULSE WIDTH (cm)			0.01			Y
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		903.4768	921.9151	958.7917		
DISPERSIVITY(cm)		0.428323	0.437065	0.620632		
Co(mV)		0.459943	0.505432	0.510487		
CRITICAL RSS VALUE =			9.93E-07			

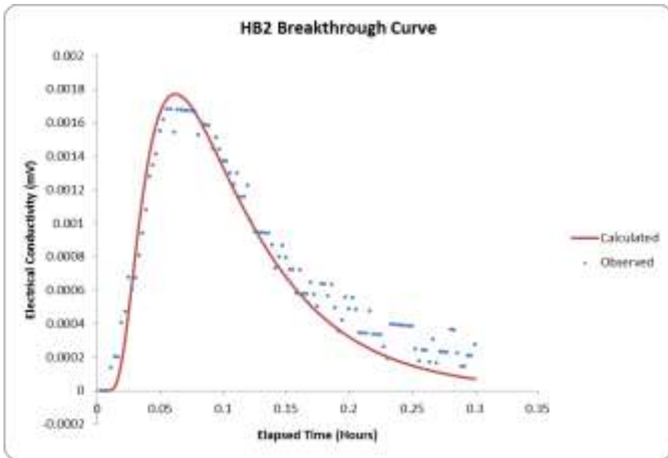
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.437064755	0.603877647	48.128455	77.92226	7.2020717	921.9151	1220.352	914.8312	914.8312	3.107E-15	.	0.84	1.36	0.125676	7.200713	914.8312	914.8312
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0705013_6cm_1601_gravel_45_0.5gL_0.25 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			837.2549	34.88562		
DISPERSIVITY (cm)			0.481883			
PULSE WIDTH (cm)			0.002255			
RF			1			
Co (mV)			2.092969			
RESDIUAL SUM OF SQUARES =				9.55E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			800			
DISPERSIVITY (cm)			0.05			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		812.1372	837.2549	879.1176		
DISPERSIVITY(cm)		0.438513	0.481883	0.602353		
PULSE WIDTH (cm)		0.002165	0.002255	0.00248		
Co(mV)		2.009251	2.092969	2.302266		
CRITICAL RSS VALUE =			1.17E-06			

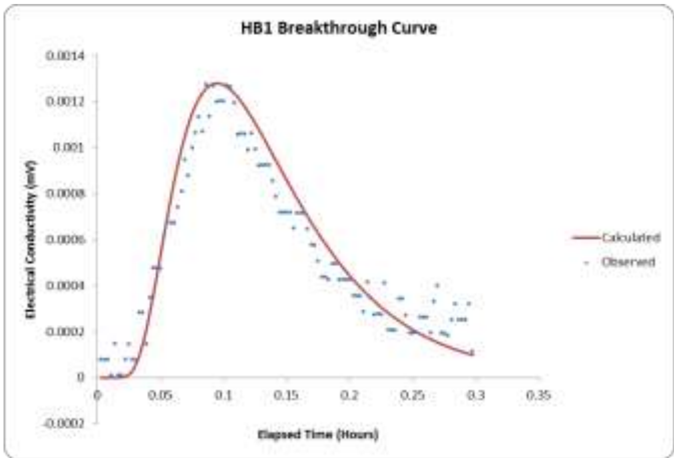
VelProbe output for 0705013_6cm_1601_gravel_45_0.5gL_0.25 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			650	27.08333		
DISPERSIVITY (cm)			0.478905			
PULSE WIDTH (cm)			0.005232			
RF			1			
Co (mV)			1.072197			
RESDIUAL SUM OF SQUARES =				1.96E-06		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			650			Y
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
DISPERSIVITY(cm)		0.431014	0.478905	0.531585		
PULSE WIDTH (cm)		0.005022	0.005232	0.005493		
Co(mV)		1.029309	1.072197	1.125807		
CRITICAL RSS VALUE =			2.17E-06			

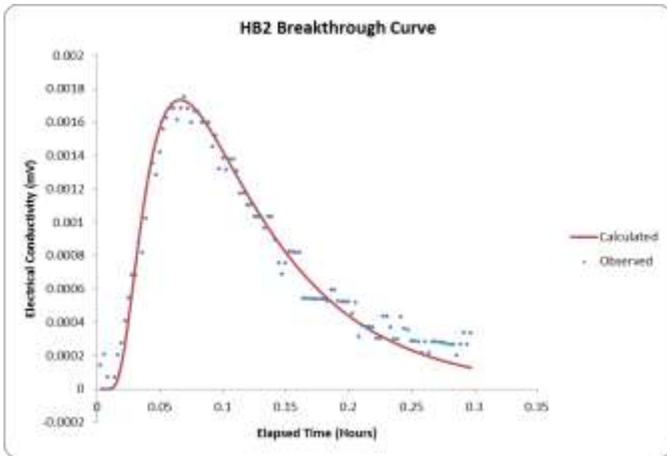
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.481882601	0.478904982	77.92226	48.128455	9.6017948	837.2549	650	603.8977	603.8977	-4.706E-15	.	1.36	0.84	0.167551	9.599983	603.8977	603.8977
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0705013_6cm_1626_gravel_45_0.5gL_0.25 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			794.1638	33.09016		
DISPERSIVITY (cm)			0.510843			
PULSE WIDTH (cm)			0.002934			
RF			1			
Co (mV)			1.955218			
RESDIUAL SUM OF SQUARES =				9.5E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			625			
DISPERSIVITY (cm)			0.35			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			4.08			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		778.2805	794.1638	841.8137		
DISPERSIVITY(cm)		0.49041	0.510843	0.745831		
PULSE WIDTH (cm)		0.002377	0.002934	0.002964		
Co(mV)		1.583726	1.955218	1.97477		
CRITICAL RSS VALUE =			1.4E-06			

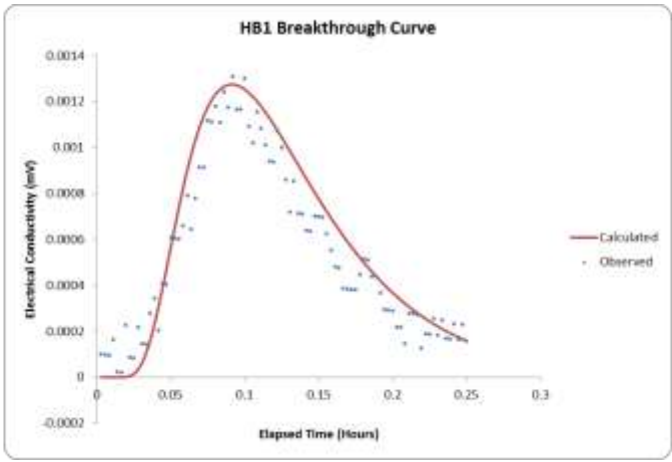
VelProbe output for 0705013_6cm_1626_gravel_45_0.5gL_0.25 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			584.4975	24.35406		
DISPERSIVITY (cm)			0.527172			
PULSE WIDTH (cm)			0.003008			
RF			1			
Co (mV)			1.872493			
RESDIUAL SUM OF SQUARES =				9.2E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			700			
DISPERSIVITY (cm)			0.35			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		561.1176	584.4975	596.1875		
DISPERSIVITY(cm)		0.500813	0.527172	0.595704		
PULSE WIDTH (cm)		0.002828	0.003008	0.003068		
Co(mV)		1.760143	1.872493	1.909943		
CRITICAL RSS VALUE =			1.05E-06			

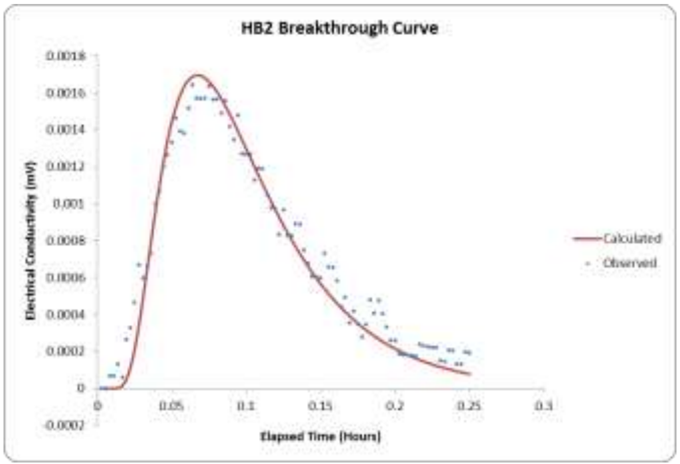
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.510843491	0.527171935	77.92226	48.128455	5.128247	794.1638	584.4975	617.1875	617.1875	0	.	1.36	0.84	0.089488	5.12728	617.1875	617.1875
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 0705013_6cm_1656_gravel_45_0.5gL_0.25 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES					
			cm/hr		
VELOCITY(cm/d)		837.3748	34.89062		
DISPERSIVITY (cm)		0.484954			
PULSE WIDTH (cm)		0.002548			
RF		1			
Co (mV)		2.199932			
RESDIUAL SUM OF SQUARES =			9.27E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS					
					FIX
VELOCITY(cm/d)		750			
DISPERSIVITY (cm)		0.35			
PULSE WIDTH (cm)		0.02			
RF		1			Y
Co (mV)		2			
DISTANCE FROM SOURCE (cm)		4.08			Y
DIFFUSION COEFF (cm^2/sec)		0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS					
Parameter	Low	Optimized	High		
VELOCITY(cm/d)	820.6273	837.3748	929.4861		
DISPERSIVITY(cm)	0.451007	0.484954	0.717732		
PULSE WIDTH (cm)	0.001886	0.002548	0.002574		
Co(mV)	1.62795	2.199932	2.221931		
CRITICAL RSS VALUE =		1.67E-06			

VelProbe output for 0705013_6cm_1656_gravel_45_0.5gL_0.25 – Half Bridge 2



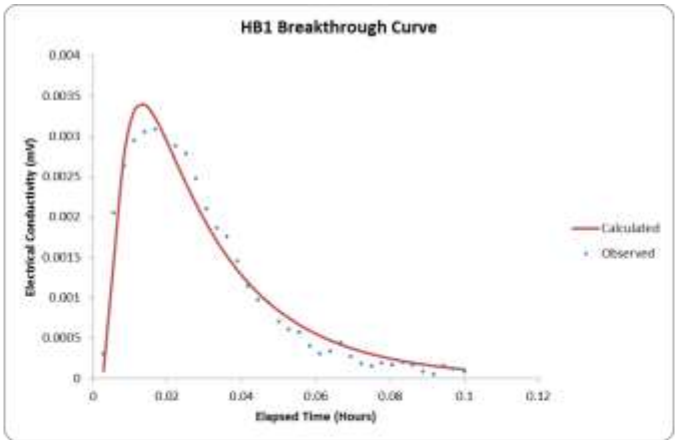
OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			676.4643	28.18601		
DISPERSIVITY (cm)			0.367209			
PULSE WIDTH (cm)			0.001897			
RF			1			
Co (mV)			2.543442			
RESDIUAL SUM OF SQUARES =				9.31E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			700			
DISPERSIVITY (cm)			0.35			
PULSE WIDTH (cm)			0.02			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			2.52			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		622.3471	676.4643	683.2289		
DISPERSIVITY(cm)		0.341504	0.367209	0.425962		
PULSE WIDTH (cm)		0.001821	0.001897	0.001992		
Co(mV)		2.441704	2.543442	2.670614		
CRITICAL RSS VALUE =			1.09E-06			

Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.484954009	0.367208503	77.92226	48.128455	13.583933	837.3748	676.4643	570.3973	570.3973	-9.966E-15	.	1.36	0.84	0.23704	13.58137	570.3973	570.3973
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VELPROBE OUTPUT

2 cm PVP Data for Gravel

VelProbe output for 07082013_2cm_1523_gravel_45_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES

		cm/hr
VELOCITY(cm/d)	1344.339	56.01411
DISPERSIVITY (cm)	0.416611	
PULSE WIDTH (cm)	0.005937	
RF	1	
Co (mV)	1.10358	

RESDIUAL SUM OF SQUARES = 1.35E-06

INITIAL GUESSES AND INPUT OF PARAMETERS

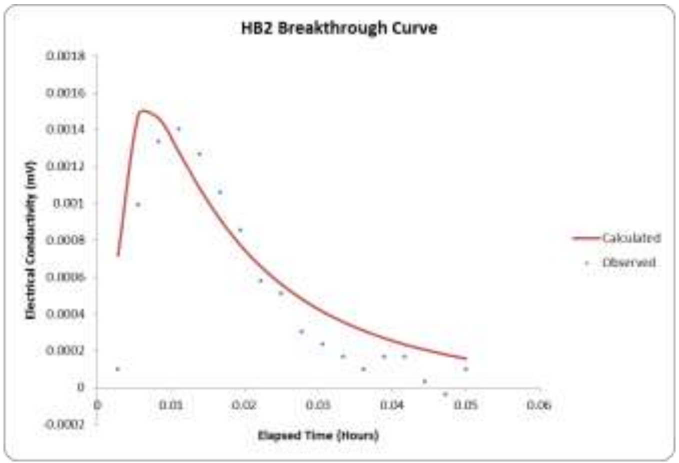
		FIX
VELOCITY(cm/d)	900	
DISPERSIVITY (cm)	0.1	
PULSE WIDTH (cm)	0.01	
RF	1	Y
Co (mV)	2	
DISTANCE FROM SOURCE (cm)	1.39	Y
DIFFUSION COEFF (cm^2/sec)	0.000001	Y

95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS

Parameter	Low	Optimized	High
VELOCITY(cm/d)	1250.235	1344.339	1451.886
DISPERSIVITY(cm)	0.345787	0.416611	0.504099
PULSE WIDTH (cm)	0.005462	0.005937	0.006412
Co(mV)	1.015294	1.10358	1.191867

CRITICAL RSS VALUE = 2E-06

VelProbe output for 07082013_2cm_1523_gravel_45_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES

		cm/hr
VELOCITY(cm/d)	1307.369	54.47372
DISPERSIVITY (cm)	0.382968	
PULSE WIDTH (cm)	0.000944	
RF	1	
Co (mV)	2.032942	

RESDIUAL SUM OF SQUARES = 9.58E-07

INITIAL GUESSES AND INPUT OF PARAMETERS

		FIX
VELOCITY(cm/d)	1100	
DISPERSIVITY (cm)	0.3	
PULSE WIDTH (cm)	0.01	
RF	1	Y
Co (mV)	2	
DISTANCE FROM SOURCE (cm)	0.894	Y
DIFFUSION COEFF (cm^2/sec)	0.000001	Y

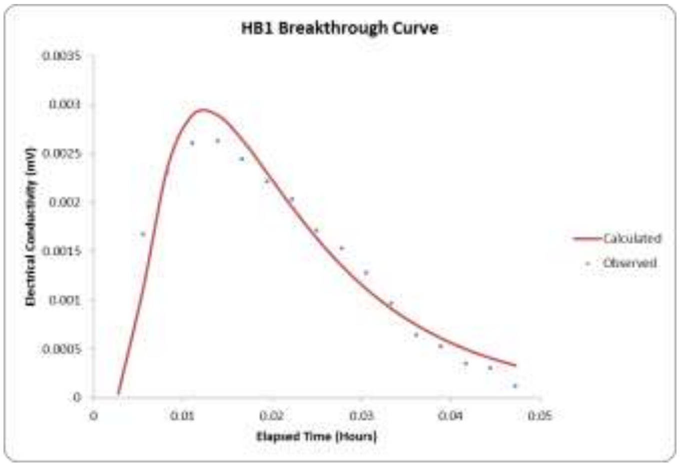
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS

Parameter	Low	Optimized	High
VELOCITY(cm/d)	889.0111	1307.369	1751.875
DISPERSIVITY(cm)	0.114891	0.382968	0.536156
PULSE WIDTH (cm)	0.00051	0.000944	0.001152
Co(mV)	1.097789	2.032942	2.480189

CRITICAL RSS VALUE = 2.05E-06

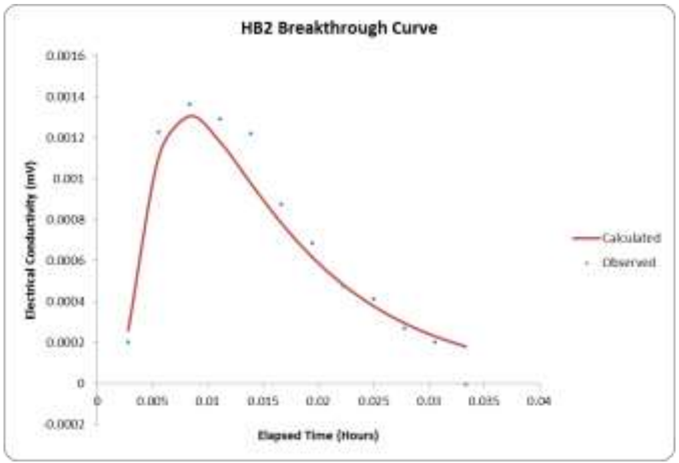
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.416610769	0.382968464	79.641134	51.222427	40.301863	1344.339	1307.369	740.488	740.488	3.838E-15	.	1.39	0.894	0.703268	40.29426	740.488	740.488
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 07082013_2cm_1537_gravel_45_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			1770.6	73.77498		
DISPERSIVITY (cm)			0.272647			
PULSE WIDTH (cm)			0.003106			
RF			1			
Co (mV)			1.668473			
RESDIUAL SUM OF SQUARES =				6.85E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			600			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		1628.952	1770.6	2036.19		
DISPERSIVITY(cm)		0.226297	0.272647	0.441688		
PULSE WIDTH (cm)		0.002609	0.003106	0.003417		
Co(mV)		1.401517	1.668473	1.83532		
CRITICAL RSS VALUE =			1.53E-06			

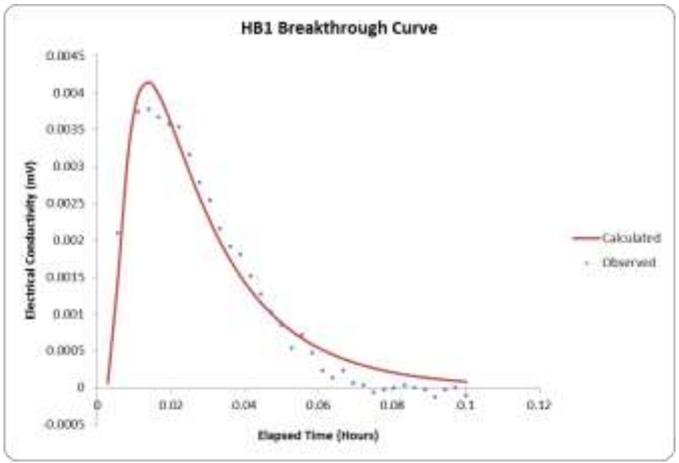
VelProbe output for 07082013_2cm_1537_gravel_45_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			1587.88	66.16168		
DISPERSIVITY (cm)			0.213558			
PULSE WIDTH (cm)			0.001091			
RF			1			
Co (mV)			1.424503			
RESDIUAL SUM OF SQUARES =				1.42E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			600			
DISPERSIVITY (cm)			0.07			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		1302.062	1587.88	1841.941		
DISPERSIVITY(cm)		0.115321	0.213558	0.288304		
PULSE WIDTH (cm)		0.000949	0.001091	0.00144		
Co(mV)		1.239317	1.424503	1.880344		
CRITICAL RSS VALUE =			4.47E-07			

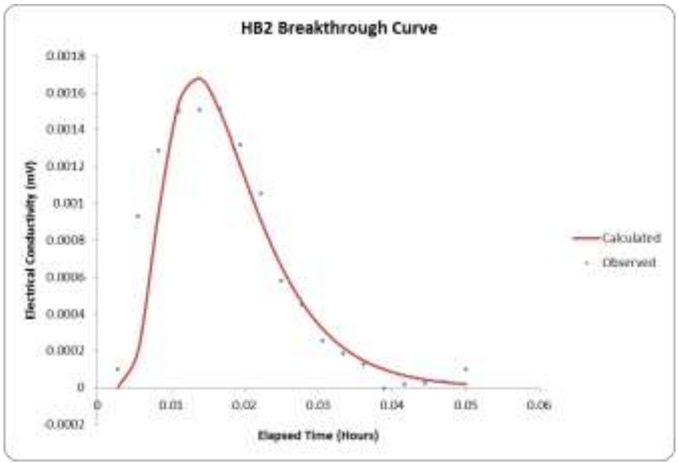
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.21355832	0.272646645	51.222427	79.641134	25.100178	1587.88	1770.6	1060.854	1060.854	0	.	0.894	1.39	0.437998	25.09544	1060.854	1060.854
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 07082013_2cm_1545_gravel_45_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			1424.306	59.34608		
DISPERSIVITY (cm)			0.356537			
PULSE WIDTH (cm)			0.009824			
RF			1			
Co (mV)			0.790831			
RESDIUAL SUM OF SQUARES =				1.95E-06		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			800			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		1324.605	1424.306	1538.25		
DISPERSIVITY(cm)		0.295926	0.356537	0.43141		
PULSE WIDTH (cm)		0.009038	0.009824	0.01061		
Co(mV)		0.727564	0.790831	0.854097		
CRITICAL RSS VALUE =			2.88E-06			

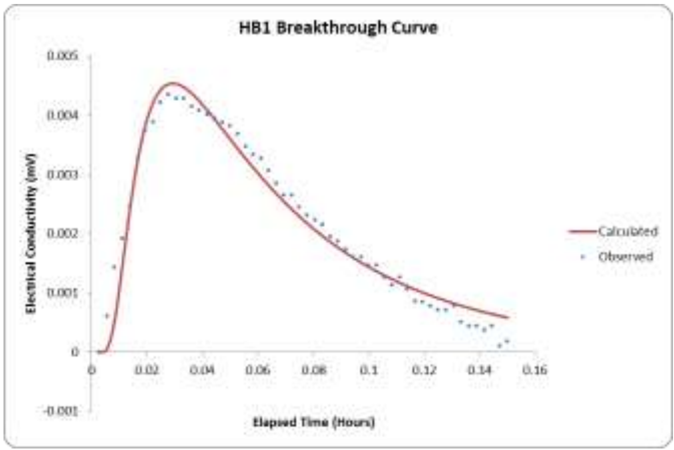
VelProbe output for 07082013_2cm_1545_gravel_45_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			1305.666	54.40276		
DISPERSIVITY (cm)			0.090046			
PULSE WIDTH (cm)			0.001089			
RF			1			
Co (mV)			1.4			
RESDIUAL SUM OF SQUARES =				7.39E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			1160			
DISPERSIVITY (cm)			0.08			
PULSE WIDTH (cm)			0.001			
RF			1			Y
Co (mV)			1.4			Y
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		1188.156	1305.666	1619.026		
DISPERSIVITY(cm)		0.065734	0.090046	0.249427		
PULSE WIDTH (cm)		0.000871	0.001089	0.001361		
CRITICAL RSS VALUE =			1.33E-06			

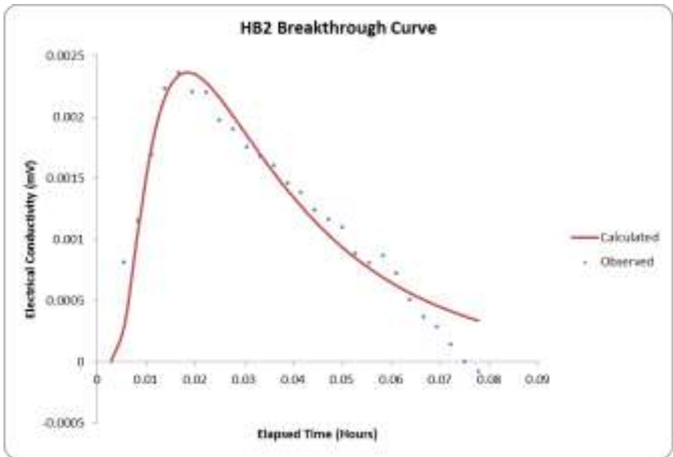
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.090045947	0.356537036	51.222427	79.641134	28.836919	1305.666	1424.306	829.825	829.825	3.425E-15	.	0.894	1.39	0.503204	28.83148	829.825	829.825
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 07082013_2cm_1627_gravel_45_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			589.571	24.56546		
DISPERSIVITY (cm)			0.424985			
PULSE WIDTH (cm)			0.010741			
RF			1			
Co (mV)			0.814333			
RESDIUAL SUM OF SQUARES =				3.33E-06		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			1000			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		560.0924	589.571	619.0495		
DISPERSIVITY(cm)		0.378237	0.424985	0.475983		
PULSE WIDTH (cm)		0.010204	0.010741	0.011278		
Co(mV)		0.773617	0.814333	0.85505		
CRITICAL RSS VALUE =			4.33E-06			

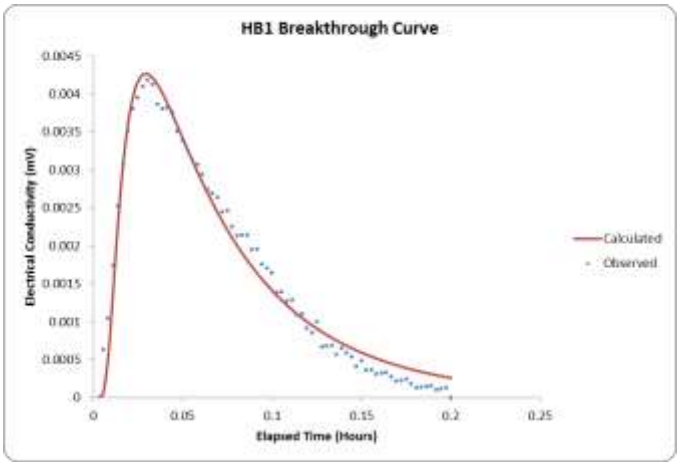
VelProbe output for 07082013_2cm_1627_gravel_45_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			678.936	28.289		
DISPERSIVITY (cm)			0.224023			
PULSE WIDTH (cm)			0.001211			
RF			1			
Co (mV)			2.342307			
RESDIUAL SUM OF SQUARES =				9.16E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			800			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		631.4105	678.936	767.1977		
DISPERSIVITY(cm)		0.18818	0.224023	0.306912		
PULSE WIDTH (cm)		0.001078	0.001211	0.00132		
Co(mV)		2.084653	2.342307	2.553114		
CRITICAL RSS VALUE =			1.5E-06			

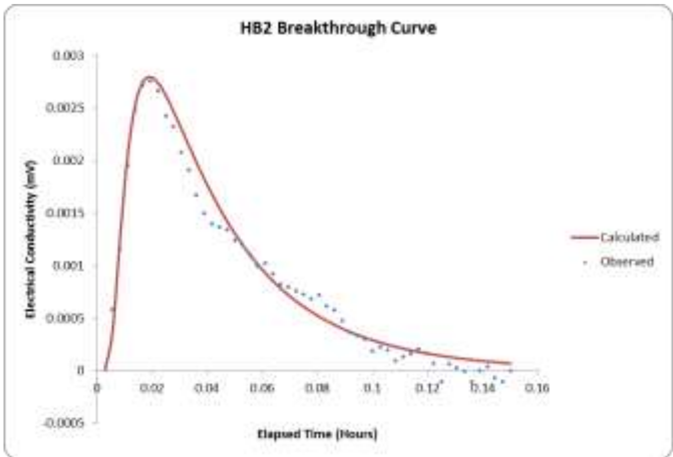
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.224023398	0.42498492	51.222427	79.641134	77.707594	678.936	589.571	360.723	360.723	-3.94E-15	.	0.894	1.39	1.355998	77.69293	360.723	360.723
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 07082013_2cm_1644_gravel_45_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			576.9651	24.04021		
DISPERSIVITY (cm)			0.436716			
PULSE WIDTH (cm)			0.002695			
RF			1			
Co (mV)			3.070759			
RESDIUAL SUM OF SQUARES =				2.53E-06		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			600			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		559.6561	576.9651	600.0437		
DISPERSIVITY(cm)		0.401779	0.436716	0.47602		
PULSE WIDTH (cm)		0.002587	0.002695	0.002803		
Co(mV)		2.947929	3.070759	3.193589		
CRITICAL RSS VALUE =			3.09E-06			

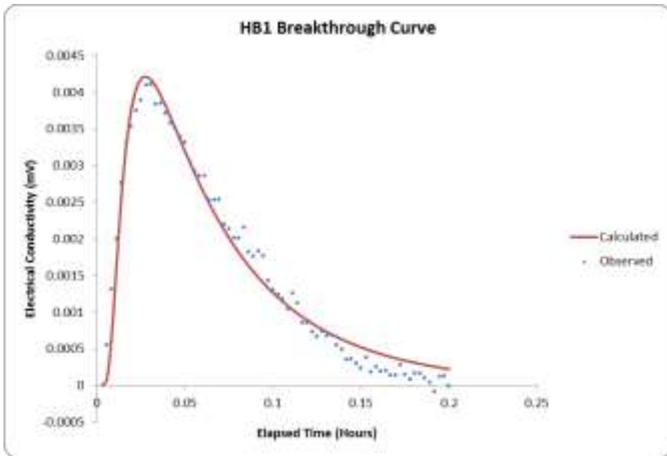
VelProbe output for 07082013_2cm_1644_gravel_45_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			608.5475	25.35615		
DISPERSIVITY (cm)			0.257452			
PULSE WIDTH (cm)			0.001142			
RF			1			
Co (mV)			3.017473			
RESDIUAL SUM OF SQUARES =				9.07E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			700			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		590.2911	608.5475	669.4023		
DISPERSIVITY(cm)		0.242005	0.257452	0.321815		
PULSE WIDTH (cm)		0.000993	0.001142	0.001164		
Co(mV)		2.625201	3.017473	3.077822		
CRITICAL RSS VALUE =			1.26E-06			

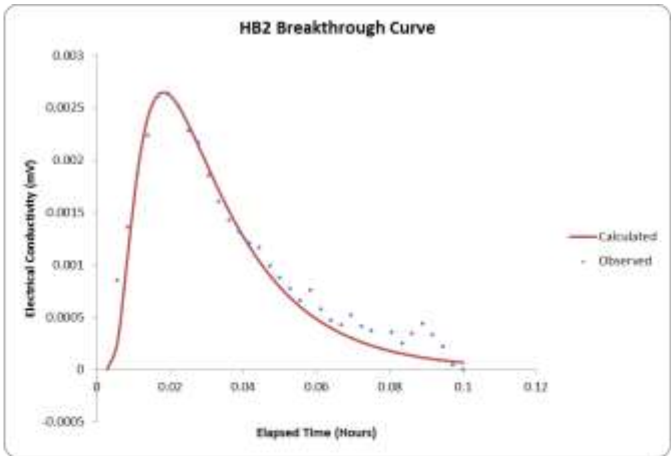
Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.257451752	0.436716045	51.222427	79.641134	58.439112	608.5475	576.9651	316.3583	316.3583	4.492E-15	.	0.894	1.39	1.019763	58.42809	316.3583	316.3583
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							

VelProbe output for 07082013_2cm_1710_gravel_45_0.5gL_0.1 – Half Bridge 1



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			604.2552	25.1773		
DISPERSIVITY (cm)			0.453076			
PULSE WIDTH (cm)			0.009738			
RF			1			
Co (mV)			0.838376			
RESDIUAL SUM OF SQUARES =				3.12E-06		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			500			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			1.39			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		580.085	604.2552	634.4679		
DISPERSIVITY(cm)		0.407769	0.453076	0.502915		
PULSE WIDTH (cm)		0.009348	0.009738	0.010127		
Co(mV)		0.804841	0.838376	0.871911		
CRITICAL RSS VALUE =			3.8E-06			

VelProbe output for 07082013_2cm_1710_gravel_45_0.5gL_0.1 – Half Bridge 2



OPTIMIZED PARAMETER ESTIMATES						
				cm/hr		
VELOCITY(cm/d)			762.8057	31.78357		
DISPERSIVITY (cm)			0.177819			
PULSE WIDTH (cm)			0.001286			
RF			1			
Co (mV)			2.304272			
RESDIUAL SUM OF SQUARES =				9.68E-07		
INITIAL GUESSES AND INPUT OF PARAMETERS						
						FIX
VELOCITY(cm/d)			750			
DISPERSIVITY (cm)			0.1			
PULSE WIDTH (cm)			0.01			
RF			1			Y
Co (mV)			2			
DISTANCE FROM SOURCE (cm)			0.894			Y
DIFFUSION COEFF (cm^2/sec)			0.000001			Y
95% CONFIDENCE INTERVALS FOR ESTIMATED PARAMETERS						
Parameter		Low	Optimized	High		
VELOCITY(cm/d)		709.4093	762.8057	816.2021		
DISPERSIVITY(cm)		0.160037	0.177819	0.259615		
PULSE WIDTH (cm)		0.001196	0.001286	0.001414		
Co(mV)		2.142973	2.304272	2.534699		
CRITICAL RSS VALUE =			1.43E-06			

Probe Name	Dispersivity 1 (cm)	Dispersivity 2 (cm)	Gamma 1 (Degrees)	Gamma 2 (Degrees)	Estimated Alpha (Degrees)	Apparent Velocity 1 (cm/d)	Apparent Velocity 2 (cm/d)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)	Percent Difference	Manual Calcs. -->	Gamma 1 (radians)	Gamma 2 (radians)	Est. Alpha (radians)	Est. Alpha (degrees)	Average Linear Velocity 1 (cm/d)	Average Linear Velocity 2 (cm/d)
Probe 1	0.177818546	0.453076223	51.222427	79.641134	93.75891	762.8057	604.2552	452.4978	452.4978	-2.007E-12	.	0.894	1.39	-1.5055	-86.2588	-452.498	-452.498
Probe 2	0	0	0	0	0	0	0	0	0	65535							
Probe 3	0	0	0	0	0	0	0	0	0	65535							
Probe 4	0	0	0	0	0	0	0	0	0	65535							
Probe 5	0	0	0	0	0	0	0	0	0	65535							
Probe 6	0	0	0	0	0	0	0	0	0	65535							
Probe 7	0	0	0	0	0	0	0	0	0	65535							
Probe 8	0	0	0	0	0	0	0	0	0	65535							